No 2674 VOLUME 77 FRIDAY 10 JUNE 1960

FLIGHT

AIRCRAFT, SPACECRAFT, MISSILES

Official Organ of the Royal Aero Club First Aeronautical Weekly in the World Founded 1909

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Iliffe & Sons Ltd, Dorset House, Stamford Street, London SE1; telephone Waterloo 3333. Telegrams Flightpres Sedist London. Annual subscriptions: Home £4 15s. Overseas £5. Canada and USA $15.00. Second Class Mail privileges authorized at New York, NY.

Branch Offices Coventry: 8-10 Corporation Street; telephone Coventry 25210. Birmingham: King Edward House, New Street, 2; telephone Midland 7191. Manchester: 260 Deansgate, 3; telephone Blackfriars 4412 or Deansgate 3595. Glasgow: 26B Renfield Street, C2; telephone Central 1265.

New York, NY: Thomas Skinner & Co (Publishers) Ltd, 111 Broadway 6; telephone Digby 9-1197.

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The Other Half . . .

IT was particularly pleasing the other week to publish a Correspondence letter from the assistant director of engineering of the Niagara Frontier Division of the Bell Aircraft Corporation. Having congratulated Short Brothers and Rolls-Royce on the transition of the Short SC.1 on April 6 and outlined Bell's own endeavours in the VTO field (likewise on a "slimly funded and supported programme"), the writer observed: "Thomas Edison, who once stated that the aeroplane was only half invented as long as it needed to race the length of a runway before it could fly, would no doubt be gratified with the progress that Bell, Ryan and Short Brothers have made in developing the 'other half'."

Gratification would certainly be in order, for the SC.1's achievement is assuredly a major break-through in the history of aeronautical progress, and as such it was described by Sir Matthew Slattery, chairman of Shorts, at a demonstration of transition last week (page 780). Moreover, the technical description in this issue is likely to be studied abroad with more assiduity than any in the history of this journal—which amounts to the history of practical British flying. For here is the first manifestation of the concept of integration in the design of airframe, powerplant and systems—integration which in the next 10-15 years will bring into being a whole new family of aerial vehicles—prolific, versatile and safe. Already Shorts are confident that they could build a variety of military machines on the basic SC.1 system, though in recollection of troubles now behind them (and they were many and vexing) and in recognition of problems that lie ahead, they do not foresee a VTO airliner at work before 1975. This realistic view they have shared with Rolls-Royce for some years past. One recalls Dr C. T. Hewson's lecture, in April 1958, on the Griffith supersonic VTOL airliner proposal. On that occasion it was emphasized by spokesmen of both companies that the Griffith airliner was still 20 years off. The point was also driven home that, although VTOL was even at that time with us, it would be tragic if Great Britain came to couple it with this far-off dream, wherein the VTOL system would be simply a means to an end. The danger was foreseen that we might link VTOL with the enormous development costs of the distant supersonic project and fail to apply it to more immediate needs.

. . . a "Practical Proposition"

In this issue also a special contribution by H. G. Conway, Short's youthful and energetic joint deputy managing director and chief engineer, reiterates, and develops, the foregoing theme. "Clearly," Mr Conway writes, "we have demonstrated that the engineering installations on the aircraft are such that reliable and easy transitions are possible and that jet-lift vertical take-off and landing is a practical proposition . . . Although it may not have been a clear objective when we started, it is true that a result of this work is the development of a control system immediately suitable to operational aircraft." He is quick to add that a lot of work remains to be done to optimize the technique.

Meanwhile, numerous and various design proposals advanced by Shorts are under Ministerial scrutiny; and meanwhile, too, there is much activity in the rival —Bristol Siddeley—camp, hard at work on VTO schemes of its own. A Bristol Siddeley statement a few days ago remarked that, although a number of jet-lift aircraft have been built, they have shown that it is a long step from the bare achievement of jet-lift to the production of a jet-lift machine for military or civil use. Nevertheless, their own system will soon be exploited in the Hawker P.1127, and schemes for a complete range of types and classes are proposed.

All of which suggests a strong resolve that Britain shall be the first country to provide the "other half" required by America's Thomas Alva Edison.

FROM ALL QUARTERS

SC.1 Transition Demonstrated

LAST week at RAE Bedford, the Short SC.1 jet lift aircraft demonstrated to the Press a complete flight cycle of vertical take-off, wing-supported circuit and vertical landing—a most impressive but extremely noisy performance (a full description of the SC.1 begins on page 793). Take-off from the platform and subsequent hover clearly showed the precise stabilization achieved and the aircraft raced forward into winged flight as soon as the lift engines were tilted forward and the thrust engine opened up. Winged flight was achieved remarkably quickly without any helicopter-like attitude changes. The circuit was flown at about 180kt at a few hundred feet and a level deceleration transition was made from 140kt to hover in about 400yd with only a slight nose-up attitude. The SC.1 moved briefly backwards before settling gently on to the ground. The instant the wheels touched the ground, power was cut and the SC.1 settled, fully compressing its long-stroke oleos. The pilot was Tom Brooke-Smith, who has been responsible for all the development flying.

Speaking after the demonstration, Rear Admiral Sir Matthew Slattery, Hugh Conway and David Keith Lucas, respectively chairman, chief engineer and technical director of Shorts, stressed that the SC.1 has a fully developed three-channel control and stabilization system which could now be supplied by Shorts for any jet-lift VTOL project. Shorts themselves did not necessarily contemplate producing a complete aircraft, but they felt it highly desirable that the Services should acquire some VTOL aircraft in order to gain operating experience and pave the way for civil exploitation. Several Short projects exist for a reconnaissance strike fighter of high subsonic performance, the most attractive of which has been made possible by the recent offer of Rolls-Royce engines with a thrust/weight ratio of 16:1.

The final application of jet lift would be to a high-supersonic Griffith-type transport, but it remained to be proved that this could be economical. Shorts had a strong hunch that it would. The airlines would be ready to consider such a type in 1975. Lord Douglas, chairman of BEA, who chose the Press demonstration day to see the SC.1, nodded approvingly when this point was made.

Shorts estimate that the control and stabilization system would represent some 18 per cent of a complete project. They themselves have spent about £2.5m on the SC.1 so far. Besides Short, Hawker and Messerschmitt have the main VTO projects in Europe, with SNECMA rumoured as contenders with a tilt-nose, delta-winged vertical riser. There is a NATO requirement which Short, Messerschmitt and, presumably, SNECMA could meet. Shorts stressed that they could offer either a complete aircraft or a fully usable control system.

Rolls-Royce and Allison

ALTHOUGH neither side appears to have made any formal statement—certainly the British firm has not—the following text published by *American Aviation Daily* on May 25 is typical of several stories circulated in America during the past six weeks: "Allison division of General Motors and Rolls-Royce have reached an agreement under which Allison will build RB.141 and RB.160-series engines in the United States and will share in development costs. The engines . . . built both in England and the US . . . would be interchangeable. The Allison-built engines would be designated as ARB.141 and ARB.160 . . . Allison is not expected to tool up . . . unless some US purchases are assured . . ."

SONIC SALVO from XG313, one of the 20 development Lightnings, comprises 48 spin-stabilized 2in rockets rippled from a pair of retractable Microcell launchers. Alternative armament comprises twin Firestreak missiles or an extra pair of Aden 30mm guns. The picture is one frame from a cine film issued by English Electric

Record Engine Exports

EXPORTS of British aero-engines during April reached a record figure of £7,508,149. This brought the total engine exports since 1945 to over £300m (£307,392,494), and the total for the first four months of 1960 to a record £25,112,379. The latter figure compares with £19½m for the equivalent period last year, itself 25 per cent up on 1958's January-April total.

The overall value of aviation exports in the first four months of 1960 was £51,624,048. The April figure, £12,282,182, was made up as follows: aircraft and parts, £4,066,128; aero-engines and parts, £7,508,149; electrical equipment, £392,520; aeronautical instruments, £237,696; and tyres, £77,689. India was the leading customer, spending £712,565, followed by New Zealand (£685,565) and the US (£385,270).

National Air Races: First Round

AFTER a break of 22 years the London to Cardiff air race was flown again last Friday, between White Waltham and Rhoose. Speed differential between the entries ranged from less than 100 m.p.h. for the Turbulents to more than 300 m.p.h. for the Spitfire Mk 8 entered by V. H. Bellamy of the Hampshire Aeroplane Club, but poor visibility and a tendency to overheat reduced the Spitfire's average speed to 222 m.p.h. Winner of the Claude Grahame-White Challenge Cup for the first man home was J. Stewart-Wood in an Auster Mk V. He covered the course in just under 51min at an average speed of 134½ m.p.h. Second was Wg Cdr McIntosh in the Cessna 175 and third G. C. Marler in a Jackaroo. Miss Gillian Cazalet, flying a Tiger Moth, was placed fourth.

In the short-circuit races the following day trophy winners were decided on the aggregate of points scored in the three- and four-lap class races and on class results in the London-to-Cardiff race, but monetary prizes were awarded for the first four across the line. Winner of Class 1 was Percy Blamire (Gemini 3C) but the Air League Challenge Cup went to D. H. Hartas (Jodel D.117), who finished second. The Norton-Griffiths Challenge Trophy in Class 2 was won by Stewart-Wood (who finished fourth), largely as a result of points won in the London - Cardiff race. Sqn Ldr John Severne in G-APNZ, the Turbulent entered by the Duke of Edinburgh, won the race and £30, and second was C. P. Francis, also flying a Turbulent. The third race of the day, the de Havilland Tiger Moth Challenge Trophy, was won by Miss Sheila Scott flying her own Jackaroo. She shared the trophy with Geoffrey Marler (Jackaroo), who finished fifth. Beverley Snook was placed second in Tiger Moth G-ANZZ.

THE TENTH COUNTRY to buy English Electric Canberras is Sweden. Seen before delivery, and wearing the triple-crown insignia of Sweden's air force (the admiration of many others) is a T.Mk11, Rolls-Royce Avon powered, like all British-built standard marks of Canberra

New Sipa

FIRST details are now available from France of a new Sipa aircraft called the S.270 Présence. It is a twin-boom, high-wing passenger utility type resembling the Noratlas, but powered by two Turboméca Astazou turboprops giving 500 h.p. each. Rear doors allow direct loading, parachuting and access for cars up to 15ft 9in long. The pressurized cabin will accommodate 12 first-class or 16 economy-seated passengers or between 2,200 and 3,300lb of freight. Up to eight stretchers may be installed.

The Présence is in the design stage as a private venture and no first flight date has yet been given. Other details are: Span, 54ft 3in; length, 42ft 8in; wing area, 355 sq ft; aspect ratio, 8.25 : 1; root chord, 8ft 3in; equipped weight, 5,410lb; useful load, 4,160lb; gross weight, 9,900lb; max. speed at 9,800ft, 224 m.p.h.; cruising speed at 9,800ft, 218 m.p.h.

Money for Manpower

SPONSORS of promising manpowered aircraft projects are now eligible for financial help from the Manpowered Aircraft Group of the Royal Aeronautical Society. This money will come from recent contributions to the funds of the Group which have totalled £1,100 (of which £1,000 has come from Air Cdre J. G. Weir).

Applications for assistance should reach the Society (4 Hamilton Place, London W1) by October 31, 1960, and should include a general description of the project, three-view drawing, weight breakdown, analysis of project, including drag and power requirements, descriptive analysis of propulsion, stressing assumptions, calculations of flight duration and manoeuvrability, estimated financial outlay and time schedule to end of initial flight tests.

E. L. Bass Retires

THE retirement is announced of one of the best known figures on the technical side of the aviation fuel business—E. L. Bass, FRAeS, MIME, MIAS, FInstP, chief engineer of Shell's Aviation Division, who has had 43 years' continuous service with Royal Dutch/Shell group of companies. He began his career in the Anglo-Mexican Petroleum Company, and in 1924 was attached to the laboratory of Harry (now Sir Harry) Ricardo, who on Shell's behalf was making his classic studies of knock ratings. In 1932 Mr Bass took charge of the technical division of the Shell Aviation Division, and at the outbreak of war was seconded to the Air Ministry and then to MAP, in which he held responsible posts; for a period he was attached to the British Air Commission in Washington, and he was also in charge of the work which Shell's aero-engine research laboratory carried out for MAP. Since the war he has been principally concerned with jet fuels, and more recently with refuelling requirements for commercial aircraft.

Gulfstream in Britain

THE first Grumman Gulfstream to visit Britain came to Gatwick from Teterboro, New Jersey, via Goose and Keflavik last week. Thirty-six are now operating and 12 more are on order, and this was one of two used by the National Distillers and Chemical Corporation, who also run a Super Ventura, two Twin Bonanzas and a Queen Air. The transatlantic flight took 12 flying hours in an elapsed 36hr and the crew spoke highly both of the quality of the aircraft as a whole and of its two Rolls-Royce Dart RDa.7 engines—which, they said, were "a revelation" in low maintenance requirements.

OLYMPUS TEST-BED at Bristol Siddeley's Patchway Works is viewed by AVM R. N. Bateson, Assistant Chief of the Air Staff (Operational Requirements), during a recent visit. AVM Bateson, who was accompanied by Air Cdre I. G. Esplin, Director of Operational Requirements (A), is seen with the company's technical director, Dr S. G. Hooker

CUSTOM-BUILT FURNISHING of the Grumman Gulfstream which recently visited Gatwick (news item on this page)
"Flight" photograph

All Gulfstreams are delivered as a flyable bare airframe and furnished to individual customer's requirements. This particular machine had an eight-seat lounge cabin with a bed and toilet and high-fi radio and tape player. It was equipped with Bendix radio, weather radar and integrated instruments, Sperry SP.20 autopilot and Collins HF radio.

More than 23 per cent of the basic cost of $960,000 is accounted for by British equipment and the final cost usually reaches $1m to $1.1m. Grumman are offering delivery in July and are stepping up production from three to four Gulfstreams per month. A market survey is now under way in Europe and it is hoped that at least 12 will be sold on this side of the Atlantic, five of them in Britain. Break-even point for Grumman lies between 125 and 150 aircraft.

The Gulfstream has a range of 2,200 miles with 200 miles and 25min reserve and a cruising speed of 350 m.p.h. at 25,000ft. It is entirely independent of apron-servicing assistance, having built-in stairs and a turbine a.p.u. which will generate electricity and run the air-conditioning system on the ground. It can use the same fields as a DC-3 at full load. Single-engined ceiling is 17,000ft. Harold Curtis, National Distillers pilot, described the Gulfstream as a "real baby-carriage" to fly. Both the company's Gulfstreams are averaging between 50hr and 55hr per month.

IN BRIEF

The Royal Navy's first guided missile destroyer, HMS *Devonshire*, is to be launched at Birkenhead today (Friday) by Princess Alexandra. The ship's armament includes one Seaslug and two Seacat systems, and she can carry a Westland Wessex helicopter.

Saab have concluded an agreement with the Swiss aircraft manufacturers Pilatus Flugzeugwerke Ag, Stans, for the sale of the Pilatus PC6 Porter in northern European countries.

Durham UAS scored 335 points in the Hack Trophy competition on May 28, not 235 as given in the official results, and were placed third.

The Valiant of No 214 Sqn which on May 25/26 flew non-stop to Singapore in the record time of 15hr 35min set up another record on its homeward journey, completing the flight from RAAF Butterworth to RAF Marham in 16hr 16½min.

Royalties from the sale of *The Smirnoff Story*, Anne Robertson Coupar's biography of the famous Russian pilot Ivan Smirnoff (published by Jarrolds at 25s), are being given to the Imperial Cancer Research Fund.

At the 16th annual forum of the American Helicopter Society President Eisenhower received a special plaque from the Society "in recognition of his extensive use of helicopter transportation" (he flies regularly in Army and Marine Corps versions of the S-58). Among others honoured was Igor Sikorsky, who received the Grover E. Bell Award in recognition of his "personal contributions" to development of the S-60 Skycrane.

The Air League of the British Empire is hoping to form its first county branch, and a party headed by Air Cdre G. J. C. Paul (secretary-general) and Gp Capt Douglas Bader recently visited Leeds-Bradford Airport in order to sound Yorkshire opinion. The latter scored a point by calling attention to a historic poster in the Yorkshire Aeroplane Club's headquarters, advertising the 1909 Doncaster meeting. "You chaps started all this," he said. "Now you might as well help to keep it going."

Twelve MPs who form the Labour Party's Aviation Group visited Westland's Yeovil works on May 31, travelling there and back in two Whirlwinds from the London heliport. The Members and their constituencies: Francis Noel-Baker, Swindon; G. R. Strauss, Vauxhall; Capt G. R. Chetwynd, Stockton-on-Tees; John Strachey, Dundee West; A. M. Skeffington, Hayes and Harlington; J. Rankin, Govan; C. A. Johnson, Lewisham South; A. E. Hunter, Feltham; Dr A. D. D. Broughton, Batley and Morley; J. Diamond, Gloucester; C. A. Howell, Perry Barr; G. de Freitas, Lincoln.

This week's (June 9) issue of our associated journal *Mechanical Handling* is a Mechanical Handling Exhibition review number.

FLIGHT SYSTEM SURVEY

Redifon Developments

DURING its first year with BOAC, the Redifon Comet flight simulator operated for 2,000hr with only 19hr of unserviceability—a record for any BOAC simulator. Only 4½hr of unserviceability were in fact traced to the simulator itself, the remainder originating in other equipment used in conjunction with it. Serviceability now stands at 99.97 per cent.

Redifon are just completing a Vanguard simulator for TCA with full motion in pitch, roll and heave. A similar simulator for the SAS Caravelle has been delivered to Stockholm. A most important export order just received is for a Caravelle simulator for United Airlines and another for a Comet type trainer for CMA Mexican Airlines. The type trainer has motion only in the pitch plane but is otherwise similar to the BOAC Comet 4 simulator.

Narco in Britain

INCREASING numbers of American lightweight radios are now coming into use in Britain, particularly in imported American business aircraft. Narco products figure prominently in these new imports and we recorded in these columns on May 6 that Vigors Aviation at Kidlington were Narco United Kingdom distributors. The Canadian distributor and export agent for Narco is the Canadian Marconi Co in Montreal and they have an associate distributor in Britain, namely A. J. Whittemore (Aeradio) Ltd based at Biggin Hill aerodrome, Kent. The English company has carried out extensive installation and repair work on many types of radio as well as those by Narco. They fitted Elliott-produced Bendix 21-series radio in one of the British-owned Piaggio P.166s and have also dealt with many other types of aircraft.

Optical Projection Display

ONE of the projects undertaken as part of the US Army/Navy Instrumentation Program has been the provision of contact analogue information to the pilot by reflection from a transparent glass screen. It was necessary that the screen itself should cause no attenuation of the shape and colour of the exterior scenery but that it should also clearly reflect in almost any ambient light conditions the patterns and indications of the contact analogue optically projected from a cathode-ray tube. The result of intensive research is the trichroic combiner in which special multiple optical coatings have been applied to a shaped glass lens in such a way that the lens reflects pure green but remains transparent to other colours. The greens in trees, grass, paints and lights contain considerable elements of blue and yellow and it was found that the human eye very rapidly accommodated itself to the loss of the small pure green element and could increase its sensitivity sufficiently to reconstitute the colour in the visual image. It was found to be essential that the display should be collimated.

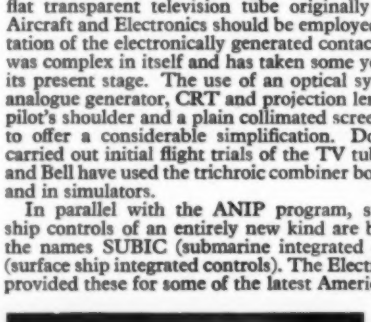
Bell Helicopter Corp proposed this method for use with a contact analogue generator produced by the Autonetics division of North American for the experimental HTL-7 helicopter used in the ANIP program. Optical Coating Laboratories Inc of Santa Rosa, Calif, developed the special coatings and the method of depositing them so that they are now hard and water-resistant. They have succeeded in programming IBM computing equipment to determine rapidly the complex composition of the multi-layer film stacks required for various applications. Initial stress-cracking problems have been overcome and the transmission or leakage in the rejected colour band has been reduced to less than 0.1 per cent. The coatings now used have even less absorption than conventional interference filters and the latest film stacks show an appreciable reduction of shift in spectrum response as the angle of incidence is varied.

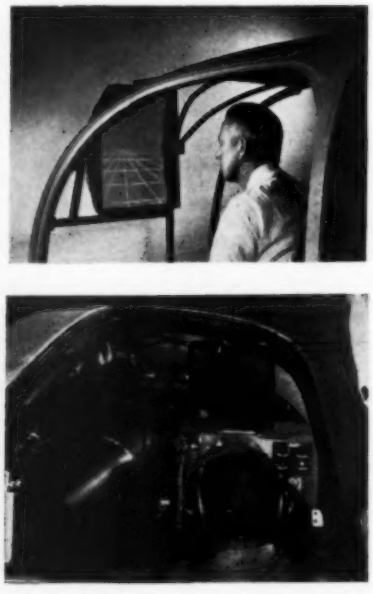
The contact analogue is generated in the CRT in green and almost any pattern or instrument indication can be projected. It has also been found possible to allow a large tolerance in the angles from which the display can be viewed. Investigations now in hand seem to indicate that tetrachroic and pentachroic combiners will in future allow the projection of two- and three-colour displays. Preliminary studies, Bell claim, hold promise of full-colour, high-contrast displays presented on the trichroic combiner now used for the single-colour patterns.

Optical Coating Laboratories found from their own earlier work that there seems to be no real limit to the angular span of the display and the main problems lie in the production of uniform high-quality trichroic coatings over large areas and in the design of unique projection optics. Also to be overcome were the effects of vibration in an installation where the optical elements were mounted on separate parts of the aircraft structure. The display can be used in both day and night conditions; and a red filter can be applied so that the display appears red for night flying.

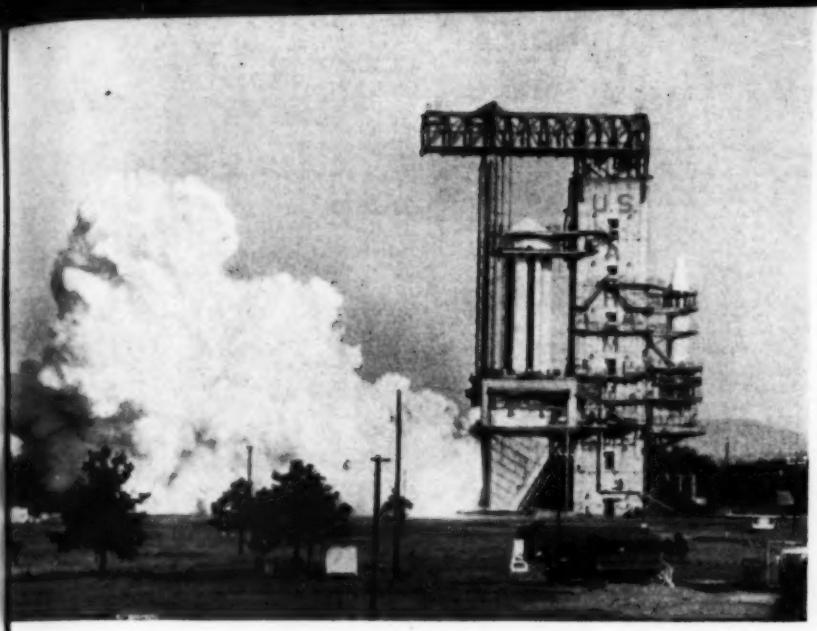
One of the most difficult elements in the contact analogue displays proposed for the airborne applications of ANIP has been in the actual presentation. Initially, it was proposed that a new flat transparent television tube originally developed by Kaiser Aircraft and Electronics should be employed for the direct presentation of the electronically generated contact analogue. The tube was complex in itself and has taken some years to develop even to its present stage. The use of an optical system, with the contact analogue generator, CRT and projection lens mounted behind the pilot's shoulder and a plain collimated screen ahead of him, seems to offer a considerable simplification. Douglas some time ago carried out initial flight trials of the TV tube in a Lockheed T2V and Bell have used the trichroic combiner both in actual helicopters and in simulators.

In parallel with the ANIP program, submarine and surface ship controls of an entirely new kind are being developed under the names SUBIC (submarine integrated controls) and SURIC (surface ship integrated controls). The Electric Boat Co has already provided these for some of the latest American submarines.





Trichroic combiners for optical projection of a blind-flying presentation. Far left, the Bell HTL-7 with combiner, Ryan Doppler and Bendix sonic altimeter. Top right, the combiner in a mock-up showing the contact analogue. Lower right, generator and combiner in an F3D Skyknight



Full-power tests on May 26 of the eight-engine Saturn first stage at the Marshall Space Flight Center, Huntsville, produced a thrust of 1,500,000lb for 35sec. Scale is given to the Saturn cluster by the Jupiter IRBM on the right of the test tower

Missiles and Spaceflight

JOINT SKY BOLT DEVELOPMENT

ALTHOUGH at the time of going to press no official statement had been issued, it seems clear that the mission of the British Defence Minister, Harold Watkinson, to his American opposite number, Thomas S. Gates, has brought evidence that more than lip-service is being paid to the problem of providing a joint Western deterrent. On the night of June 1 the two defence chiefs exchanged formal letters of intent on the Sky Bolt air-launched ballistic missile.

The most that can be said of this important weapon was contained on page 436 of our issue of April 1. After three years of intensive feasibility studies and study contracts by many American companies the US Air Force awarded Douglas Aircraft the prime contract for a complete ALBM system under the designation of GAM-87A. From the outset various Service and civilian people in Britain have eyed the programme closely, and our interest in the concept certainly goes back a lot further than the cancellation of Blue Streak. It is also quite clear that, although GAM-87A for Strategic Air Command will be one hundred per cent American and completely uncompromised, our own missile will be tailored from the outset for RAF Bomber Command.

As we have emphasized before, no technical consideration is expected to cause much difficulty, apart from one or two problems of guidance. Less critical items, and certainly the warhead, are likely to be produced in the United Kingdom to British specifications. From now onwards, personnel from British ministries and from Bomber Command—and doubtless from industry also—will be increasingly committed to the development of the British Sky Bolt, and all development will be conducted in the most intimate co-operation with the United States. It would appear inescapable that the RAF weapon will by no means be a Chinese copy of GAM-87A, although it would be foolish to embark on any design change which might require duplication of the development effort.

It is difficult to understand why there should be such controversy over our choice of this weapon. Once one accepts the fact that we cannot afford Polaris, the ALBM seems highly attractive and should prove an effective delivery system even without a standing airborne alert. The British missile will be carried by the Vulcan B.2 on underwing pylons. The aircraft could lift four, but two appears the probable standard load. There is no requirement to convert all the V-force, and in any case the Victor's wing is rather close to the ground for an installation to be attractive. At some time after 1965 the optimum carrier vehicle will be the "Super-VC10" bomber/transport. SAC's plans call for the first B-52H Hound Dog units to convert to the new weapon in the winter of 1964-65. Doubtless Blue Steel, our own cruise-type weapon roughly comparable to Hound Dog, will also be replaced by the ALBM over a similar time-scale.

LOOKING-OUT IN SPACE

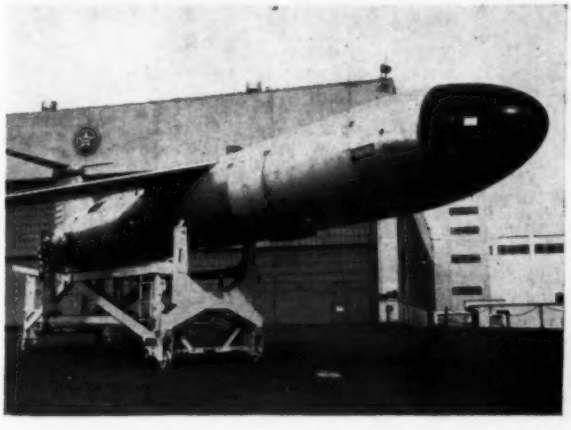
American industry competition is now keen in the bid for the National Aeronautics and Space Administration contract for an orbiting astronomical observatory. Details of the function and likely design of the OAO have been disclosed in a number of technical papers during recent months, and it is probable that construction of this challenging vehicle will begin this autumn.

The papers include *Design Considerations for an Orbiting Astronomical Observatory*, by William Triplett of the NASA Ames Research Center (presented at the American Rocket Society semi-annual meeting in Los Angeles last month); *Satellite Astronomical Observatories*, by Dr Nancy Roman, head of the NASA astronomy and astrophysics programmes; and *An Orbiting Astronomical Telescope Design Study*, by I. A. Schroader and J. G. Chubbuck of the Applied Physics Laboratory, Johns Hopkins University (also ARS papers).

In addition to viewing the Sun, the OAO will undoubtedly look towards other stars and the planets. It may be that the observatory (reported to mount a 36in mirror) will permit determination of the nature of the canals on Mars. Other observations, taken in the infra-red range, should enable us to look for the first time into the centre of our own galaxy; and the OAO should assist also in determining the nature of interstellar dust.

According to Dr Roman, orbiting telescopes may enable us to detect the presence of planets surrounding nearby stars. Another question to be answered with data derived from a satellite observatory was whether distant galaxies were identical to our own. As another justification for the programme, the OAO should permit the observation of galaxies at distances of several times that which could be reached by the 200in mirror at Mt Palomar.

From Triplett's paper comes the information that the OAO will be designed for a lifetime in orbit of one year. The projected launch date is some three years hence. Tentatively, an orbital inclination of 30° to 35° is planned, and if all goes well the observatory will be placed in circular orbit at 500 miles altitude. A satellite weight of 3,000lb is contemplated (suggesting Atlas-Agena as the booster), and a general-purpose vehicle is envisaged. No wave-length limitation is to be inherent in the design, save that imposed by the specific optical system and by the available radiation analysers. Typical radiation analysers will include video cameras, spectrographs, photo-electric cells and possibly a Land-type camera (with scanned reproductions). [*Cont. overleaf*



Weighing 5,700lb, this new launcher for the Martin TM-76B Mace is fabricated from box-section steel and is of better design than the original model. The front mounting frame is hinged at its lower end

Evidence of the steady progress of the Minuteman ICBM system towards the flight-test stage is provided by these blockhouses at the Minuteman complex at Cape Canaveral. Actual flight trials are scheduled to start in November

Missiles and Spaceflight . . .

The OAO will comprise a satellite structure, optical equipment, a control system, a command system and a telemetering/communications system. A ground station will, of course, be employed to receive data and issue commands as required.

A possible mode of operation of the OAO, as discussed by Schroader and Chubbuck, would call for the satellite to rely upon a Sun-seeker for orientation immediately after booster separation. The Sun-seeker would lock on to the Sun and provide stabilization about two axes to within one minute of arc. A star-tracker would next be utilized to seek out a star on which to lock and stop vehicle rotation about the Sun-established axis. Having established a three-axis reference system, the OAO, by means of ground or on-board (stored) command, could then be slewed to point at some target object.

Among the technical problems posed by the proposed programme, a primary need is for exceptionally precise attitude stabilization. A requirement for satellite stabilization to within 0.1sec of arc is envisaged. Because of the destabilizing effect of the Earth's gravity on asymmetric bodies, the OAO should be so designed that the moments of inertia about all three axes are exactly equal. Since in practice this will not be realized, it was assumed by Mr Triplett that the moments would differ by no more than one per cent.

Solar radiation (the infinitesimal pressure caused by the Sun's rays) is also bothersome; this suggests that the centre of solar pressure should coincide with the vehicle's centre of gravity. Even at 500 miles altitude the remaining traces of the atmosphere cause some air drag, and to prevent unbalanced forces there is a need to keep the centre of air pressure at the satellite c.g.

Should the vehicle contain appreciable amounts of magnetic material, harmful imbalances would be caused by the vagaries of the Earth's magnetic field. Further nuisances can be caused by the optical aberration effect due to the ratio of orbital velocity to the velocity of light. This effect causes the apparent position of a star to shift ±5sec during each orbit.

How each of these problems will be resolved remains to be seen. The significance of the programme has been summed up by Dr Roman. "Anticipation is high," she said, "that the next twenty years will open up possibilities for space astronomical observatories which will be as important and as long-lasting in their results as the development of the telescope was four centuries earlier."

LONG-DISTANCE JOURNEYMAN

Radiation measurements at distances of 25,000-30,000 miles from the Earth will be made later this year by space sounding rockets launched by the US Air Force. A new four-stage solid-propellant vehicle, Journeyman, will be used to carry an instrument package which will telemeter measurements as the rocket passes through the two natural-radiation belts surrounding the Earth, and above the upper edge of the outer Belt. The rockets will burn-up on re-entering the Earth's atmosphere.

TELESCOPIC OCTET

A payload of eight optical telescopes was carried in an Aerobee-Hi rocket to a height of 135 miles after launching from White Sands, New Mexico, on May 27. The telescopes were above the effective atmosphere of the Earth for a period of 5min during the flight, which was the responsibility of the US Naval Research Laboratory, Washington. Scientists at the NRL expect that the analysis of the data telemetered back will provide the most complete mapping of the stars yet achieved.

LAST REDSTONE ENGINE

Last month the Rocketdyne division of North American Aviation delivered from their plant at Canoga Park, Cal, the last of the "A" series engines (probably an A-8) produced for the US Army Redstone since 1953. Burning liquid oxygen and alcohol, these engines were the last big US units to employ continuous-sheet chambers and refractory deflection vanes. Thrust rose to 78,000lb in final models. So far 61 Redstones have been launched, all but the third being completely free from propulsion troubles, and it was largely as a result of their reliability that Redstones were inserted into the Mercury programme (the Astronauts will first ride on a Redstone, preparatory to being placed in orbit by an Atlas).

BMEWS DEPLOYMENT

It is at last possible to outline the equipment disposition at the three US Air Force ballistic-missile early-warning stations (*Flight*, January 29, page 137).

The stations at Clear, Alaska, and Thule, Greenland, will each have the giant General Electric FPS-50 detection radars (four at Thule, three at Clear); the BMEWS at Fylingdales Moor, Yorks, will be used for tracking only, and to this end will be equipped with three of the FPS-49 dishes produced by RCA.

SATELLITE SPEED-UP

Late in May the US Air Force budget director, Maj-Gen Robert J. Friedman, said that the USAF was not "actively seeking" the extra $74.4m voted by the House on May 24 for satellites and Minuteman acceleration, but that the $20.7m for the missile would assist engineering effort on its deployment and that the added $54m for Midas, Samos and Discoverer would speed the introduction of the orbiting reconnaissance vehicles "in the event that flight testing in the latter part of 1960 demonstrates the advisability of proceeding to an immediate operational capability."

Before a US astronaut is selected to make the first orbital trip in a Mercury capsule late in 1961, each of the men under training will make a ballistic flight up and down over the Atlantic. These up-and-down shots will be made this autumn.

The range of the Martin TM-76B Mace tactical air-breathing missile is now given as "up to 1,200 n.m." This is double the range of the earlier Matador, the limiting factor in all versions of the latter being its guidance system. The TM-76B has a memory-type inertial system.

According to our transatlantic contemporary *Missiles and Rockets* the US Navy air-to-air Sparrow 6B specification calls for an altitude increase of 40,000ft (presumably over Sparrow 3) and a five-year shelf life. The publication says the proponents of pre-packaged liquids and solids are each claiming their competitors cannot meet the requirement.

The launch of an Aerobee-Hi rocket carrying a payload of eight telescopes from White Sands on May 27 is reported above. In this photograph the instrumentation section is being examined by Dr H. Friedman (right), superintendent of the Atmosphere and Astrophysics Division of the Naval Research Laboratory, and J. J. Nemecek, project engineer

Missiles and Spaceflight . . .

VISIT TO VANDENBERG

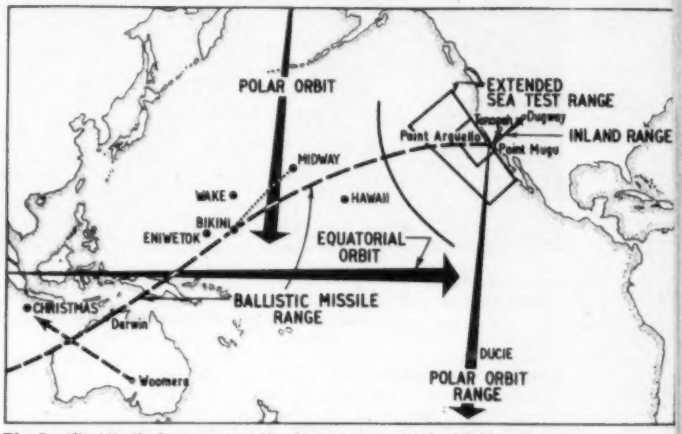
GEOGRAPHY, national need and the availability of an Army base on the Californian coast between Los Angeles and San Francisco have brought about one of the best examples of inter-service co-operation to be found today in the US defence establishment. It was in 1957 that the US Army's Camp Cooke became the base site for the Pacific Missile Range operated by the US Navy for all armed services and NASA, and of Vandenberg Air Force Base, where the US Air Force's 1st Missile Division is now ready to fire its Atlases in the event of all-out war. In addition, the Air Force has assigned responsibility to Vandenberg for launching Air Force space research projects, including the polar-orbiting Discoverer series.

To cite one example, the launching of each Discoverer satellite at PMR has been a joint effort, with the Air Force handling the vehicle and launching pad and the Navy directing the over-all efforts of the Pacific Missile Range. Similarly, future launching of Samos and Midas vehicles will find Navy and Air Force personnel working side by side to carry out the projects.

Certain over-all base duties have been assumed by the Navy, others by the Air Force, and the visitor gets a genuine feeling of co-operation among the personnel, many of whom are highly qualified technical people more interested in the research that is under way than in advancing the cause of a particular Service.

The Pacific Missile Range went into operation on May 10, 1958, and in its first 12 months carried out 6,709 range requirements, of which 2,405 were launchings of missiles or space vehicles and 4,304 were support operations. It consists of several ranges, some of them reaching far out into the Pacific, and others several hundred miles inland, as far as Tonopah, Nevada and Dugway, Utah. There is a Sea Test Range, an IRBM Range, ICBM Range, the Polar Orbit Range, and the Equatorial Orbit Range (see map). The Navy acts as executive agent for these, and exercises management control, range operation and safety, and has responsibility for range development. It is a Navy officer who must decide, for example, when it is necessary to push the "destruct" button to destroy a missile or space vehicle when it goes off course.

The Navy conducts area clearance before each "shoot" and maintains regular patrols so as to keep track of fishing and pleasure craft that may come into the area of the Pacific Missile Range during a firing. Range control and liaison, ground safety, range instrumentation, meteorology and photography are all Navy responsibilities.



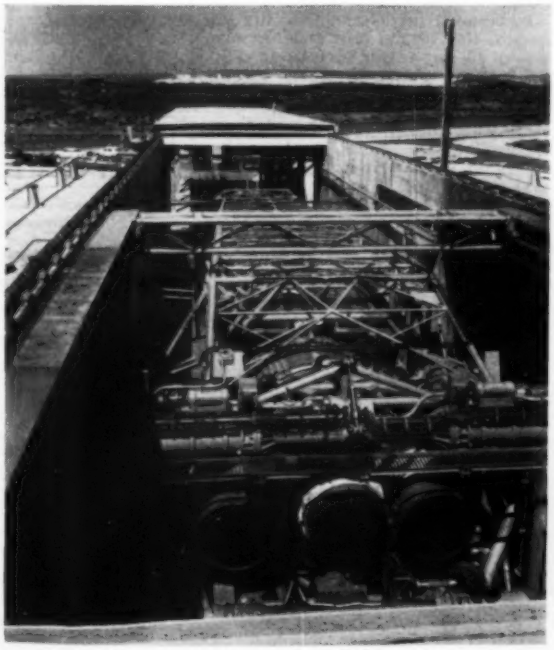
The Pacific Missile Range area. Headquarters are at the US Navy base at Pt Mugu, on the Californian coast north of Los Angeles; on the coast nearby are the Naval Missile Facility at Pt Arguello, and Vandenberg Air Force Base, the major launching site

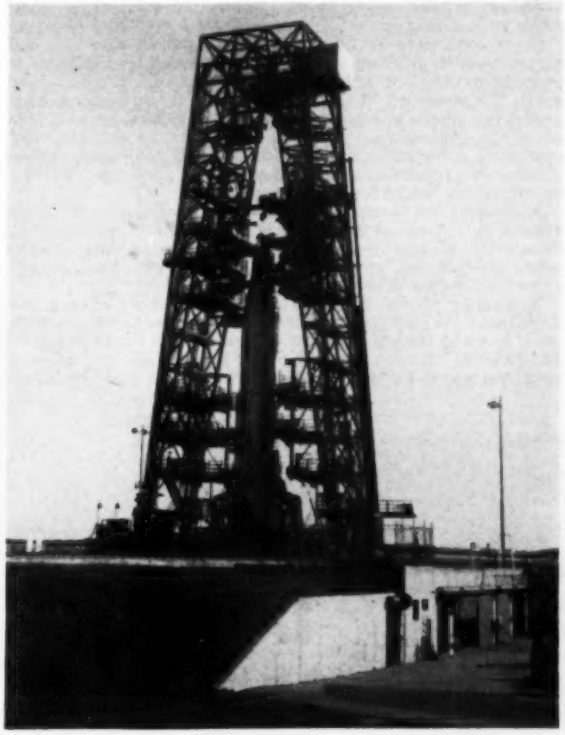
So fast has the work progressed at both the Pacific Missile Range and Vandenberg Air Force Base that time was not even taken to run complete security checks on the regiment of engineers and construction workers who have been building launching pads, control centres, communication nets, roadways and moving mountains of earth.

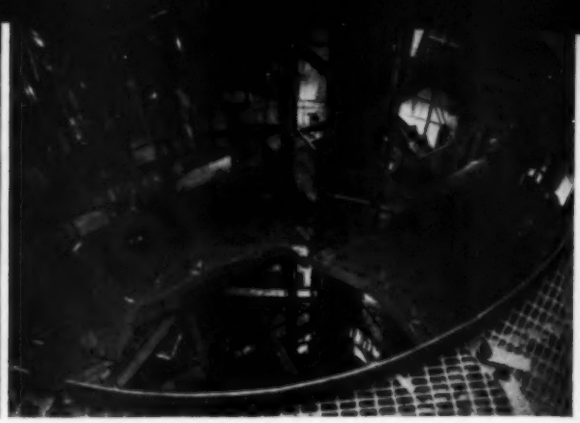
At Vandenberg alone enough dirt has been moved to put missile control, storage and launching facilities underground, to form a solid column of soil 40ft in diameter and half a mile high. Total cost of the construction, which has been under way for almost three years, is $100 million. A whole city is being built, including 46,000 homes, recreational facilities, schools, water, sewer and electrical systems, a hospital and even a jail.

At Vandenberg, three open-air launch pads have been constructed for the Atlas. The pads are set more or less in a triangle about a half mile apart, and Atlas ICBMs are kept on them, ready for fuelling and firing in the event of war. To date only three pads

Both vertical (right) and horizontal (below) pads are used for Atlas firings at Vandenberg AFB. The roof on the horizontal type takes only 17sec to slide back, and 2min is required to erect the missile







Underground tunnels (left) connect Titan silo with control centre, a quarter of a mile away. Special conduits for operational tests are carried in right-hand trays; permanent conduits are in roof. Profusion of metal bracing and temporary flooring is seen in the Titan silo (right); note elevator shaft in which the missile will be raised to ground level

VISIT TO VANDENBERG . . .

of this vertical type are set up at Vandenberg, and at the time of the visit here described (early in May) only two pads carried missiles. The third pad had been almost completely wrecked by the explosion of a missile on the launching pad. Launching is directed from a separate, underground blockhouse.

Maj-Gen David Wade, Commander of the Strategic Air Command's 1st Missile Division, says that Vandenberg's geographical location "strongly favours its selection as a launching point for the more advanced space systems that operate in a polar orbit." These launchings can be made to the south, over the Pacific Ocean, so that first-stage boosters can fall harmlessly in the water. Vandenberg already has been designated as the launching site for the future Samos and Midas projects.

Newest of the launching pads to be completed at Vandenberg are of the horizontal type. At these, Atlas missiles are brought to the site aboard trailers and are left in a horizontal position until time to fire. A metal apron forms a roof over the missile. At firing time it is pulled back, and the Atlas is raised to a vertical position for fuelling and firing. The entire operation is carried out in 15 minutes. A second Atlas may be kept in readiness on the loading ramp of each horizontal launching pad, and can be backed into position as soon as the first Atlas has been fired.

Complete fuel facilities, including tanks of oxygen and kerosine as well as tanks of nitrogen for purging, are located at each horizontal launcher. At the time of our visit one Atlas had been fired successfully from one of the new horizontal pads, and another of the missiles had to be destroyed upon take-off.

The pads have two walls of reinforced concrete 12in thick. The roof normally covers the launch site, but rolls back along an elevated track over an open-sided loading ramp that connects with a road. It requires 17sec to move the roof, two minutes to erect the missile, and fuelling and other operations can be carried out in the remainder of the 15-minute period. It is not possible to fuel the missile in a horizontal position. Nosecones with warheads are installed on the missile at the site, an operation that takes only a few minutes. The warhead will not explode unless it has been pre-armed, and this is done only when the missile is on course and headed for the target.

At present the missiles are guided on their course from the ground by radio, and there is only one guidance system for all three pads. All-inertial systems will be installed in Atlas missiles soon, however, and no ground guidance will then be necessary, according to Gen Wade.

Everything needed to launch an Atlas is present at each pad. Admittedly the pads have not been hardened and could not withstand a nearby nuclear blow, but they do provide better protection and facilities than the open-air gantry arrangement that has been used heretofore. A large control centre for all three horizontal launching pads has been built underground. From here some 80,000 pairs of cables extend to each launching pad for missile check-out and launching.

For training purposes, Atlases are fired with dummy warheads and are launched out over the Pacific to impact near Wake Island. Under wartime conditions, the missiles will be equipped with warheads that can deliver either an air-burst or a ground-burst. Appropriate instructions for whichever type of burst is desired can be fed into the nosecone electronically.

A command-destruct system is employed at all Vandenberg launching sites, though such systems will not be installed at other ICBM bases. With this system the missile can be destroyed if it goes off course. It is felt the command-destruct system is a necessary adjunct to the training activities at Vandenberg.

One radio-guidance system is used for all three pads at present, and each Atlas missile is guided for six minutes after firing. Thereafter it follows a ballistic trajectory. The two booster engines on Atlas drop off after 2½ minutes of flight, thus leaving behind 9,000lb of equipment. The single sustainer engine cuts-off after five minutes of flight, at which time the vernier engines come on until the proper course is established for the missile.

Once the course has been established, the verniers are cut-off and two small solid retro-rockets are fired to back-off the nosecone from the main body of the Atlas. Both continue on the established trajectory and both tank and nosecone end up in the target area.

ICBM Maintenance

Each Atlas missile is on 180-day recycling schedule. This means that upon arrival and every six months thereafter it goes through a careful inspection lasting four to six weeks at the Vandenberg maintenance base. Electrical circuits are carefully checked out, tanks are examined and wiped internally so as to remove even the tiniest piece of dirt that might have collected inside, and engines are tested.

In cleaning the tanks of an Atlas, Air Force personnel wear surgical clothes, and tape their wrists and ankles. "Black light" is used to inspect the interior of each tank. Tech 901 solvent is used for cleaning purposes, and wiping is carried out with Scotchwipe, a special industrial wipe that is lint-free. Two men work together inside a tank during the cleaning process and are fed oxygen through an air hose and face-masks. The interior of the tank is kept filled with inert nitrogen gas.

Cleanliness is extremely important, particularly inside the oxygen tank, since oxygen may sometimes explode when it comes in contact with unoxidized materials. Even a short piece of hair left inside an oxygen tank may cause an explosion, according to maintenance personnel at Vandenberg.

At all times the Atlas is kept either under pressure of 5½lb/sq in in the oxygen tank and 8 lb/sq in in the fuel tank; or the entire missile is kept "in stretch" on a steel frame. A pulling force of 10,000lb is required to hold the missile "in stretch" and, when either pressure or stretch is removed, the stainless steel tanks (whose skin is thinner than a US dime) tend to wrinkle.

At another location at the Vandenberg base the US Corps of Engineers is hurrying completion of the first silo for launching Titan ICBMs. This particular location at Vandenberg will be used for operational testing purposes.

An elevator is being installed to raise the Titan above ground and into the firing position. Fuel storage and complete control facilities are also being established deep underground, all with interconnecting tunnels. Double-locked doors close the tunnels between control centres and missile silos during firing. Missile check-out, silo operating and power-distribution equipment, silo air-conditioning and other equipment are installed in a second underground silo adjacent to each Titan silo.

Once a missile has been fired, it may take as long as two days before a second Titan can be loaded into the silo again, since each missile must be "built up" on the elevator a section at a time before it can be lowered into the silo.

Missile trajectories are presented visually on these plot boards from data supplied by computer. Up to five boards may be used per firing

JET FUEL AND SAFETY

Some Facts about JP.4 and Kerosine

By J. W. RICKARD

IN a speech earlier this year, Lord Brabazon, chairman of the ARB, drew attention to some unfavourable trends affecting air safety, one of which was the use of "petrol" instead of kerosine in turbine-engined aircraft. He suggested that if passengers died as a result of this "inexcusable" practice, the operators of the aircraft should be charged with manslaughter.

Those not directly concerned with powerplants and their fuels may well have been puzzled by so drastic a stricture. If recent discussions at the IATA Technical Conference (*Flight*, May 13 and May 20) are any guide, the airlines do not seem particularly perturbed at the proposal that both types of fuel should be used.

For piston-engined aircraft the use of aviation gasoline has long been accepted as a necessary evil. From the earliest days of flying, spillage of this volatile fuel has always presented a most formidable fire hazard, and in some accidents people have died by fire and not as a result of impact. But the advent of the turbine engine made it possible to use a lower-volatility fuel, and in the early post-war years it was confidently predicted that the use of kerosine in airlines would usher in an era of greater safety. Before long, however, there appeared an intermediate type of fuel comprising kerosine and gasoline fractions, the object being to obtain maximum yield from a given quantity of crude oil.

This new fuel, which is known as JP.4 or "wide-cut gasoline," was selected some years ago by a Canadian international airline for their turbine aircraft. It is also believed to be in at least occasional use now by two American and two European international operators.

How safe is this fuel? Can these airlines be accused of compromising highest standards of safety? To answer these questions we must take a comprehensive look at those properties of the two fuels which affect safety.

Flash Point. In order for a fuel to burn, a vapour/air mixture of the correct proportions must be formed above its surface. If the mixture is either too weak or too rich it will not support combustion, although in the case of over-richness ignition can readily be produced (provided the fuel is in the open air and not in a tank) by applying the ignition source at a point some distance from the fuel surface within the weakening mixture-gradient.

Now the big difference between kerosine and JP.4 lies in their flash points; and these in turn depend on the respective volatilities or vapour pressures, kerosine having a RVP (Reid vapour pressure) of about 0.125lb/sq in absolute and JP.4 one of between 2 and 3lb/sq in abs. Therefore, in order for kerosine to produce the weakest mixture capable of supporting combustion at sea level, it must be at a temperature of at least 40°C, that is, its flash point, and fuel will be at such a temperature only during tropical operation. The flash point of JP.4, on the other hand, can be as low as −22°C, which means that this fuel is inflammable at almost all times. It follows that in the event of a crash kerosine is much less likely to ignite than is JP.4. If however, a fire does break out, kerosine flame-spread will be relatively slow, as the fire has to raise the temperature of the unburnt fuel in order to spread. But with JP.4 (and, of course, gasoline) the fire will spread violently.

At this point it must be stated that the above considerations do not entirely apply in the case of fuel *mists*, which remain inflammable at temperatures well below the quiescent flash point. Students of aircraft safety will be familiar with the excellent work of NACA, who carried out a series of full-scale crash fire investigations with both piston- and jet-engined aircraft. In these tests, the aircraft was accelerated along the runway until it hit a specially erected barrier which tore off the undercarriage and ripped open the wing leading edges. This allowed fuel to be projected forward during the subsequent deceleration, thereby ensuring large-scale generation of fuel mist. Such a mist is easily ignited regardless of the type of fuel (although kerosine still has a slight advantage), and the heat-release is so great that flash point becomes of small significance. In this type of accident survivors of the initial impact have little chance of escape. But while this type of accident can occur, the formation of an all-enveloping cloud of mist is by no means a feature of all crashes in which fuel is spilled.

In-Flight Explosion. Fig 1 shows the fuel temperature required at different altitudes for the formation of an ignitable (and hence explodable) vapour/air mixture over fuel contained within a tank. Fig 2 shows the shape of the envelopes for kerosine and for a typical JP.4 (RVP 2½lb/sq abs.) during a six-hour flight of an aircraft cruising at 40,000ft. Also plotted is a curve of typical maximum fuel temperature in an integral tank of the same aircraft, assuming a true airspeed of about 435kt, ISA conditions, and an initial fuel temperature of 15°C.

Examination of Fig 2 shows that in temperate and colder regions fuel temperature will fall within the JP.4 explosion envelope on every long flight (and on a great many short ones), whereas it remains below the kerosine weak limit. If the reader now imagines the typical fuel-temperature curve to be lifted up towards warmer climes, he will see that, although JP.4 will be too rich for explosion for most of the flight, it will often pass into its explosive envelope during the descent (it is then that lighting strikes may be encountered; this point is enlarged upon below). In tropical operation, fuel temperature will often fall within the kerosine envelope.

Although the gasoline envelope is not shown in Fig 2, it is of interest to note that, while this fuel does sometimes form an

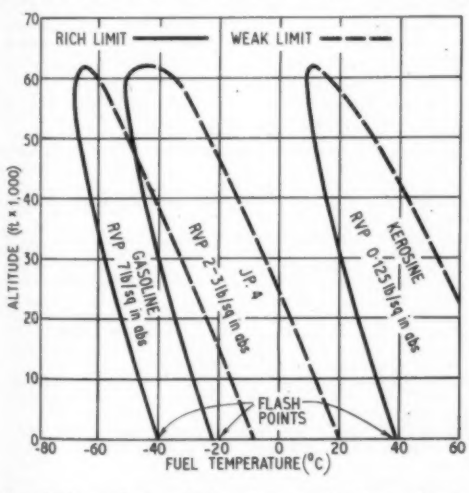


Fig 1 (left). Explosive mixtures for aircraft fuel (equilibrium conditions)

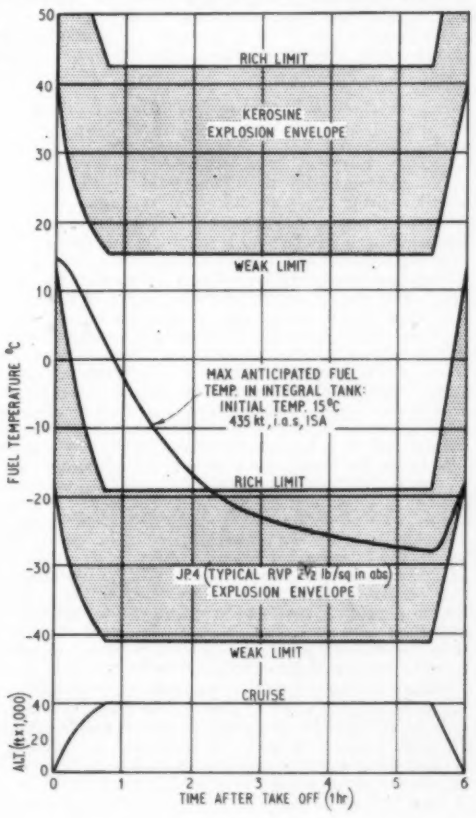

RICH LIMIT
KEROSINE EXPLOSION ENVELOPE
WEAK LIMIT
MAX ANTICIPATED FUEL TEMP. IN INTEGRAL TANK: INITIAL TEMP. 15°C 435 kt, i.a.s, ISA
RICH LIMIT
JP4 (TYPICAL RVP 2½ lb/sq in abs) EXPLOSION ENVELOPE
WEAK LIMIT
CRUISE
FUEL TEMPERATURE °C
ALT (ft x1,000)
TIME AFTER TAKE OFF (1hr)

Fig 2. Explosion envelopes and fuel temperature for typical flight profile

JET FUEL AND SAFETY . . .

explosive mixture towards the end of a long flight, gasoline/air mixtures are too rich for explosion during a large proportion of piston-engined flying.

There is no particular harm in carrying an explosive mixture in aircraft tanks unless there is also a source of ignition; but, as suggested above, lightning may provide such a source.* It has often been stated that there is no known case of an aircraft having been destroyed by lightning strike, but it looks as though such confidence may no longer be justified, for it is now believed that the loss of a TWA Constellation near Milan in the summer of 1959 was caused by a fuel-tank explosion following a lightning strike. In addition to this, tip tanks carrying JP.4 on some military aircraft are known to have been exploded by lightning. If the Constellation report is ever confirmed, the whole question of tank explosion will have to be given further careful consideration. While the primary protection against this hazard must lie in careful design of fuel systems, and granted that all fuels can form explodable mixtures at one time or another, it remains evident that JP.4 presents the worst risk in this particular regard.

Spontaneous Ignition Temperature. This is the temperature required at which a hot surface, without external spark or flame, will ignite an inflammable liquid. It is a difficult quantity to measure, being affected by many variables, the most important of which are the local ventilation velocity and the period for which the fuel is in contact with the surface. The higher the ventilation velocity, the higher the s.i.t., and the longer the contact time the lower the s.i.t.

Let us first consider in-flight fires. Tests carried out by a well-known aircraft manufacturer showed that with a small ventilating airflow, kerosine would ignite at a surface temperature of 400°C and JP.4 at 500°C, suggesting that JP.4 was slightly safer. In practice, however, engine fuel systems are confined to compressor zones, where surface temperatures are well below the above figures (although as a precautionary measure in engines of high compression-ratio, the "hot" end of the compressor may be double skinned or otherwise shrouded). Fuel pipes are not generally allowed to pass through combustion zones other than in fireproof, drained conduits, so the possibility of leakage onto the very hot parts of an engine is ruled out except in the case of a major catastrophe such as turbine failure. In addition, engine compartments are usually well ventilated; and this ventilation will in itself tend to raise s.i.t.s higher than the values quoted above.

There is no evidence of which I am aware to suggest that in-flight fires are any more common with one fuel than with the other.

Turning now to effects of spontaneous ignition temperature in crashes, crash fires are often started by fuel coming into contact with very hot engine components, both internal and, to a lesser extent, external. The turbojet engine also presents a particular hazard, as it is liable to continue rotating after a crash and to inhale any fuel in the vicinity, this fuel catching fire and resulting in a torch of flame out of both ends. Kerosine and JP.4 and gasoline are all readily ignited by spontaneous ignition under crash conditions as N.A.C.A. have shown. What is so vitally important, if one may reiterate this point, is the development of the fire after it has once started, and here the principal advantage of kerosine lies.

Fuel Freezing Point. This is the temperature at which certain constituents of a fuel start to solidify; fortunately fuels do not solidify completely at their specification freezing points, but remain fluid and pumpable for at least 5°C below. The freezing point of the kerosine most commonly used in this country is −50°C and of JP.4 −60°C, the latter fuel having a theoretical advantage; but it is an advantage which is most unlikely to be of use in practice. In one of the slower jet transports now flying, the very lowest fuel temperature which could be experienced on a long flight would be at least 25°C above ambient, in which case an ambient cooler than −75°C would be required to affect kerosine. This temperature corresponds to arctic minimum at 37,000ft and is extremely rare. The faster the aircraft the greater will be the protection conferred by kinetic heating. The slower flying turboprop aircraft, though not enjoying the same kinetic protection, will be operating at lower altitudes and therefore at higher ambient temperatures.

A fuel temperature of −47°C is the lowest of which I have heard, and this was on a Comet aircraft. If the old −40°C freezing point kerosine had been in use on this occasion, an alteration in flight plan would have been necessary to meet this rare case. So far as ground operation is concerned, the current −50°C kerosine should be satisfactory all over the world. Even at the Canadian winter establishment at Fort Churchill, sustained temperatures lower than about −42°C are rarely experienced.

Water in Fuel. All fuels contain water in solution, which is precipitated as temperature is reduced. Normally this water (and free water, if present in small quantities) is given up to the air above the fuel. Should the tank contain humid air, however, the precipitated water will remain in the fuel and form ice crystals when the temperature falls below zero. This ice will pass into the fuel pipes and settle on micronic filters.

This problem has become much more prominent since the advent of the turbine engine, partly because of the increasing use of micronic filters, but owing also to higher operating altitudes and to the use of integral tanks, these last two factors resulting in lower fuel temperatures than were common in an earlier era. There is also the theory that the problem has been aggravated by the use of kerosine which, because of its higher viscosity, may tend to hold its precipitated water in suspension, whereas the less-viscous fuels will allow their water to settle out by gravity. I am not convinced that the difference in viscosity materially affects the icing risk as between the different fuels (JP.4 can hold slightly more water in solution than can kerosine) although some airworthiness authorities think that it does. One such authority actually insisted on the removal of a 20-mesh booster pump screen from a certain British powerplant; this despite the fact that such a screen has not been known to ice-up in British turbine experience.

In practice, filter icing occurs fairly frequently with both kerosine and JP.4, and the solution has been to fit fuel-heaters, which use either hot engine oil or compressor bleed air as a heat source. We are all filter-icing-conscious these days and now realize that this phenomenon was probably responsible for many unexplained power-losses in piston engines.

Effect of Volatility on Flight Relighting. It is sometimes suggested that relighting an engine in flight is easier with JP.4 on account of the greater readiness of that fuel to vaporize. Relighting at altitude may have been a problem on some early turbine engines; but, with the advent of high-energy ignition and more highly developed fuel systems, this vital engine manœuvre can be easily performed with either type of fuel.

To summarize: from the standpoints of flight relighting, water in fuel, fuel freezing point, and spontaneous ignition temperature, there is nothing to choose in practice between the two fuels. From the standpoint of flight explosion, JP.4 presents the greater hazard when one considers world-wide operation as a whole. But from the point of view of flash point and its effect on the crash fire risk, kerosine has a clear-cut safety advantage over JP.4.

Some Crash Evidence. It is relevant to consider some crashes which have occurred to kerosine-fuelled aircraft in an effort to see how the theoretical superiority has been manifested in practice. Official reports are not available for all the accidents in the following list, and, where they are, precise details of fuel spillage and fire development are usually lacking; but as crashes do not occur under laboratory conditions this is not surprising. The list is not a complete one, and accidents in which all occupants are believed to have been killed by impact have not been included. It is worthy of note that in only one of the following cases is a technical failure known to have been the cause.

Comet 1 at Rome, October 1952. Aircraft failed to become airborne and came to rest extensively damaged, having spilled some 2,000gal of kerosine. No fire or casualties.

Viscount at Mangalore, Australia, October 1954. Training accident during engine-out take-off. Aircraft collided with trees, crashed and overturned, killing the pilots. Kerosine from ruptured tanks caught fire, but the slow development of the fire allowed the five occupants of the inverted cabin to extricate themselves and escape.

Viscount at London Airport, January 1955. Collided at high speed with runway obstructions. All propellers and reduction gears and two complete engines torn off, aircraft coming to rest in a pool of over 1,000gal of kerosine. Two small engine fires extinguished and all occupants (about 40) safely evacuated.

Viscount at Blackbushe, January 1956. Training accident during engine-out take-off. Aircraft struck ground, cartwheeled, came to rest within 200yd and caught fire. Five occupants escaped with slight injuries, after which fire almost destroyed the aircraft.

Viscount near Benghazi, August 1958. Flew into high ground and caught fire. Thirty-six killed, but fire development was sufficiently slow to allow 18 occupants (mainly from rear of cabin) to escape.

Handley Page Dart-Herald near Farnborough, August 1958. Engine failure resulting in uncontrollable fire; burning powerplant dropped off, leaving kerosine pouring from nacelle, fire still burning. Aircraft crash-landed and was slowly consumed by fire after the five occupants had escaped unhurt.

Britannia near Hurn, December 1958. Aircraft flew into ground in fog during test flight and caught fire; nine occupants killed, three escaped.

Viscount near Gatwick, February 1959. Aircraft hit trees on approach, crashed and caught fire; 15 occupants killed, ten escaped.

Comet at Asuncion, Paraguay, August 1959. Aircraft flew into trees on night approach in bad weather. Pilot and one passenger died, 63 other occupants escaped from severely damaged aircraft. No fire, although massive fuel spillage would be expected.

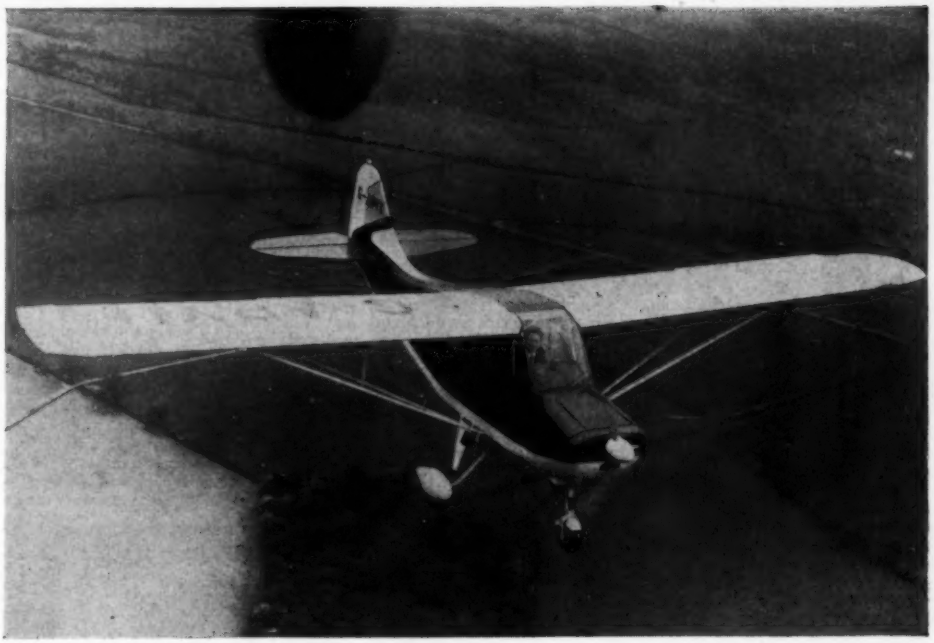
Comet at Rome, December 1959. Wheels-up landing: no casualties. No fire, although fuel spillage and sparking from abrasion on runway would be expected.

Comet at Buenos Aires, February 1960. Very heavy landing during crew training: pod tanks broke off and started a fuel fire which severely damaged the aircraft: all 11 occupants escaped unhurt.

Comet at Madrid, March 1960. Aircraft struck escarpment on night approach, losing main wheels: one wing torn off on touchdown. No fire and no casualties among crew or 24 passengers. Heavy fuel spillage and sparking through abrasion on runway would be expected in such circumstances.

[Concluded at foot of page 804

*See "Uninvited Electricity," "Flight," April 10, 1959.—Ed.



"High-wing visibility limitations were not nearly as bad as they might be, despite a 'solid" roof"

"Flight" photographs

CHAMPION TRI-TRAVELER in the Air

No 126 of the Series **By MARK LAMBERT**

THERE is a real sales opportunity in Britain for the comfortable, simple and cheap club training aircraft—something less than a business aircraft, but much, much more than a Tiger Moth. Unfortunately, low first cost is critical for the clubs and directly affects hourly operating charges so that a £4,000 to £5,000 aircraft must be used for journeys by share-paying passengers before it becomes financially acceptable. The trainer to be hired by one man at a time must therefore be cheap. Both the Cessna 150 and the Super Cub, though attractive trainers, are expensive by club standards and the two aircraft described in these pages are for that reason important newcomers to the British market.

As an overall assessment of the 90 h.p. Tri-Traveler (the makers spell it with one "l"), I would say that it is rather better as a trainer than the Super Cub 150 because it is less generously powered, a fraction more comfortable and, most important, it is cleared for full aerobatics. But it does not, of course, equal the Super Cub's phenomenal utility performance and short-field capability. The Tri-Traveler also has better visibility than the Cessna 150, a factor which is a real failing in that otherwise delightful aircraft. Even though it lacks flaps, the Tri-Traveler has good approach characteristics and it is ridiculously easy to land. Its stall is not as realistic as that of the Cessna, but a fraction more so than that of the Super Cub. None of them really stalls decisively, but then what modern aircraft does?

What really puts the Tri-Traveler in the picture is its price of £2,995, fly away Biggin Hill (delivery in two months or less), and its aerobatic capability. Six machines of the type are being imported by Maitland Drewery for a new club at Biggin Hill and the first three are already flying. Branch clubs elsewhere will follow. The Tri-Travelers are assembled at Ramsgate airfield by Aviation Engineering Services Ltd.

The only briefing I had before I flew Tri-Traveler G-APYU at Biggin Hill recently was a quick word with Mike Waterhouse, Maitland Air Charter pilot, about the location of the fuel gauge, switches and similar details. Looking around the outside of the aircraft later, I noticed that the ailerons formed a slot when raised and closed the slot when lowered—the reverse of usual practice—and that the aileron leading-edge stuck out to provide proturning drag. The elevator was spring-loaded downwards to accentuate longitudinal stability and the rudder was spring-connected to the nosewheel. Structure in general was steel tube, fabric covered, with typically smooth American dope finish in two soft colours. The undercarriage looked tough, with all three wheels encased in metal spats, one of which could be used as a footstep. Damping on the main wheels was by telescopic strut in the main leg, the inner bracing legs being simply hinged at the fuselage centre-line. The nosewheel also had a telescopic strut.

Access to the tandem, two-seat cabin was through a large doorway to starboard. The door had an inclined hinge so that it fell open against a stop on the rear wing-strut. Climbing in was easy to either seat and the cabin was exceptionally broad. The rear rudder pedals were beside the front seat and cable-connected to the front pedals. The latter were wide enough apart to allow the carriage of a sizeable dog between the pilot's feet ahead of the stick—an animal lover's dream but doubtless frowned upon by ARB. There was also an adjustable ventilator on either side just about where the dog's shoulders would be. The large window on the port side was in two halves, each of which could be slid open by either occupant. Also in reach of both occupants were the navigation-, landing-light, master and magneto switches and carburetter heat control in a wall-panel beside the front seat, together with the single fuel cock. The elevator trim handle was in the ceiling above the front pilot's left shoulder. A single fairly crude fuel gauge in the starboard wing-root showed fuel contents in both wing-root tanks. Quadrant throttles without friction nuts were positioned in the left wall for each pilot. There were no instruments in the rear.

The front seat could be screwed forward or back with a knurled knob; and heel pedals for each pilot gave good control for the very powerful hydraulic wheel-brakes. Distributed over the main panel in front were a series of cut-out blanks ready to take the full gyro instruments which are optional extras. An a.s.i. and sensitive altimeter were on the extreme left and r.p.m., and oil temperature and pressure gauges on the extreme right—all visible from the back over the pilot's shoulders. The Tri-Traveler is normally flown solo from the front seat.

Beneath the instrument space was a narrow gutter which formed a useful shelf and on the ledge below that a series of clearly marked toggles and plungers for priming, cabin heating, starting and parking brake. There was plenty of spare room for one or two small radios and a full electrical system and ignition screening are standard equipment. There was an encouragingly thick mattress of soundproofing on the front bulkhead, between occupants and engine. Thin carpeting on the floor and pleasant, washable plastic lining made the cabin cheerful.

Visibility over the nose was excellent and at least half of each tailplane could be seen at the back. The wing was fairly high above eye level so that sideways visibility was encouraging. I could just lean forward level with the leading edge and could see

CHAMPION TRI-TRAVELER in the Air . . .

very well upwards and forwards. High-wing visibility limitations were not nearly as bad as they might be, despite a "solid" roof.

A couple of shots of priming, two switches turned and a toggle tugged set the little 90 h.p. Continental in motion. The oil temperature seemed to "in the green" anywhere on the scale and I taxied out straight away. I bounced around in my seat but could not shake the tiny fuel-level tell-tale from a firm "full" indication. Take-off checks were noise, wind, fuel and trim neutral. The engine would not have kept running with fuel turned off (the cock is positively locked open) and the trim lever was a convenience rather than a necessity in view of the fixed configuration of the aircraft. The take-off check list could therefore have been halved.

Wheel-base and track were generous and the Tri-Traveler rode steadily on concrete—I had no time to try it on grass. Steering without braking was adequate for a turn about one wing-tip and addition of brake permitted turns about one wheel. With full rudder applied, I found that my heel met the brake pedals head-on, but others did not experience this difficulty. It depends on size of boot. The tightest turns with rudder alone were best made coasting with power off.

Take-off produced no surprises, with full directional control and no noticeable swing. The addition of a collar to the static probe apparently applies some optimism to the a.s.i., but the Tri-Traveler flew itself off at an indicated 60 m.p.h. and accelerated willingly to the climbing speed of 70 m.p.h. After a brief stir at the stick I timed a 1,000ft climb in 1min 20sec—with full fuel and one occupant—which is 750ft/min. The brochure figure is 900ft/min with full load. Levelling off at 2,200 r.p.m., an economical cruising setting, the a.s.i. almost touched 100 m.p.h. The brochure says 108 m.p.h. at high cruising power.

The Tri-Traveler wallowed a little in bumpy air. Neutral lateral stability could be found if the stick was tapped lightly to cancel out a certain amount of control friction. The aircraft felt generally quite light and rather more manœuverable than one would expect of an American aircraft of this kind. A good deal of rudder was required to co-ordinate a turn. Lateral stability was by no means overpowering, as it tends to be in some of the Cessnas, and use of the rudder produced a progressive bank after an initial yaw. The trimmer was high-geared, effective and precise and I easily set the aircraft to cruise hands-off for some time.

Champion Tri-Traveler (Continental C90-12F giving 90 h.p.)

Span, 33ft 5in; length, 21ft 8in; aspect ratio, 7.25 : 1; empty weight, 968lb; gross weight, 1,450lb; useful load, 482lb; baggage capacity, 50lb; wing loading; 8.8lb/sq ft; power loading, 16.5lb/h.p.; never-exceed speed 135 m.p.h.; cruising speed, 108 m.p.h.; landing speed, 42 m.p.h.; rate of climb, 900ft/min; cruising range, 500 miles; fuel capacity, 26 US gal.

All my flying was working up to aerobatics and I carefully tried to assess acceleration of both airspeed and engine r.p.m. in dives and the available rate of roll. The first two quantities increased very quickly past the end of the green stripe at 100 m.p.h. on the a.s.i. A yellow stripe allowed me up to 135 m.p.h., but then there was a commanding never-exceed red mark. I assessed the rate of roll as about 45°/sec at 90 m.p.h. and relatively constant over the speed range without undue heavying up of any control at high speeds. During a few wing-overs I found control co-ordination to be easy with plenty of reaction to spare in all axes.

Then I settled down to some stalling checks. With power off, I held height constant and, as the speed fell off steadily, I had the stick fully back at 60 m.p.h. The nose then came up a little unwillingly until at 45 m.p.h. the Tri-Traveler juddered briefly and then dropped its nose well below the horizon. The a.s.i. immediately registered 55 m.p.h. and with the stick still held hard back, the nose came up again and the performance was repeated. It continued "going downstairs" until eventually one wing dropped very slowly and it started a gentle spiral Then I let go and tried again with a little power on. The performance was substantially repeated, except that the stick stayed farther forward and the drop came at 42 m.p.h., this time with an immediate and apparently random tendency to drop one wing or another. Rudder was very effective in levelling the wings and keeping the aircraft going straight downstairs. There was no tendency to spin and I hear that no one has yet produced a genuine spin.

The moment of truth had now come and I determined to try some positive g aerobatics. The loop was an obvious first manœuvre to try but I wondered whether I would have the urge to get over the top. I dived to 130 m.p.h., having to throttle back early to avoid overspeeding the engine. To produce adequate g I had to pull the stick almost fully back and we went up and over quite nicely. The "solid" roof kept sight of the rearward horizon as a surprise in store until the last moment and I noticed the a.s.i. passing below 40 m.p.h. as I went over the top. I had to take care to avoid overspeeding on the recovery. Having proved that it could be done, I set about to tidy the loop up a bit. This time I dived less steeply and was able to use more power. At 120 m.p.h. I pulled back a trifle more firmly and we sailed nicely over the top at just above stalling speed. The second half was also better and I hit my own slipstream. Obviously there was no difficulty here, but the rapid increase in speed and r.p.m. in the dive might have to be carefully watched by an inexperienced pupil. There seemed no danger of overstressing by pulling the stick hard back. The elevator was just sufficiently powerful.

I pulled up vertically several times and found that the Tri-Traveler could be very nicely stall-turned either way. There was plenty of rudder. The most difficult manœuvre was a slow roll because I did not want to apply negative g. After a couple of preliminary wing-overs I tried a roll, starting with the nose fairly high. The rate of roll was perfectly adequate—much higher than that of a Bishop Tiger, for instance. The first time I let the nose drop deeply during the second half of the roll, in order to avoid high side-loads, but the next time I held it a good deal higher. Although, in avoiding negative g, I dived out of each roll, I see no reason why a good slow roll should not be possible.

Before aerobatics, I had flown for a few minutes in formation with *Flight's* Gemini for the accompanying photographs to be taken. Visibility was the main difficulty for this kind of flying—as it would be with any high-wing aeroplane. Otherwise control forces and throttle response and the general behaviour of the Tri-Traveler were pleasant and simple.

Finally I tried some landings. With nothing to do but check brakes and fuel, the downwind leg was unhurried and full aft trim was best selected as soon as the power was cut for the glide

"The undercarriage looked tough, with all three wheels enclosed in metal spats. . . . The nosewheel also had a telescopic strut"

in to land. The rate of descent was quite adequate, even without flaps, and forward visibility was good. I could inspect the sky best by looking outboard during an S-turn. The Continental engine seemed to have no tendency to ice up with the throttle closed—in the Jodel, the French say, you have to be very careful about this—but I made sure that power was there if needed. The round-out was not pronounced and the float, after a 70 m.p.h. approach, not long. The Tri-Traveler settled gently on to its main wheels without any bounce or pitch forward and those really powerful brakes could be used hard as soon as the nosewheel was down. I once succeeded in skidding both mainwheels on tarmac. The landing is one of the simplest and least surprising I have ever experienced and several circuits confirmed the initial impression.

By present price standards for imported aircraft, I think the Tri-Traveler is money's worth and has unsual capabilities. It ought to be a simple and reliable aircraft in club service. One could say that it will not teach people to handle the idiosyncrasies and crudities of a Tiger Moth or Magister, but then one cannot expect a modern trainer to teach people about museum pieces. One can only hope that the museum pieces themselves will retire gracefully from the scene (I fancy I hear howls of horror).

Ideally, the new trainers should have classic handling qualities to teach a new pilot what an aircraft should be like to fly. The Chipmunk is probably the best machine for this purpose, but it is too expensive. The Kos, described opposite, is apparently somewhat above the average, but there is still plenty of room for improvement. In the meantime, the Tri-Traveler fills the training bill just about as well as any of the new aircraft now available.

PZL KOS in the Air

By ALASTAIR PUGH

No 127 of the series

BEING demonstrated in Britain last month was a light two-seater that might just fit the bill for clubs and private owners whose ideal specification is covered by an aerobatic monoplane with side-by-side seating.

The Polish PZL-102B Kos (the name means Blackbird) is all-metal, powered by a production American engine and really is designed to live in the open air. Moreover, its quite modest price of £2,465 duty paid includes assorted "outdoor" covers and consumable spares worth about ten per cent of the total value of the aircraft. The agents for the Kos in Great Britain, Norco Engineering of 62 Church Road, Burgess Hill, Sussex, had made a good job of distributing descriptive literature about the aircraft before it arrived. Included was a list of these apparently comprehensive expendable spares, among them tyres and tubes, a large number of metric and special tools and assorted nuts, washers, split pins and even locking wire. There are a hundred or so bits and pieces in all apart from the items which form essential ground equipment. Other spares will be obtainable through Norco Engineering.

The Kos is thus being offered for sale in Great Britain with a satisfactory measure of engineering support. Also, 20 have already been built and sold variously to the Lebanon, Finland and Brazil. The aircraft brought to Britain at the end of last month was a factory prototype, which on the way had been demonstrated in Austria, Switzerland and France. I thought that it showed a number of signs of being an early model, even apart from rather faded blue and yellow paint, but special modifications were extraordinarily few. For getting about Europe, a French 8-channel Artus Airvox VHF set had been strapped on to a piece of sponge rubber over the tunnel between the pilots' knees. It was easy to reach and simple to tune. The only other non-standard fitment was beading angle riveted to the elevator trailing edges to increase control effectiveness.

Immediately noticeable on the ground is that maximum thickness of the wing occurs at only about 15 per cent chord; apart from any aerodynamic advantages this does mean that the torsion box ahead of the spar gains rigidity from its depth. Aft of the spar the wing is fabric covered, as are all control surfaces. The fuselage is in two sections, all the centre section and forwards being steel tube covered with unstressed sheet, while the aft fuselage is semi-monocoque joined on by four bolts. Although fuselage-mounted, the oleo-pneumatic main undercarriage legs are quite wide-tracked and appear sturdy. Span-to-track ratio is 5 : 1. The tailwheel is non-steerable and castors through 180°; it is suspended by a tension spring. A tube through the rear fuselage which acts as a jacking support and grab is a permanent fixture.

War-time austerity is recalled by these registration letters, but the Kos is quite extensively equipped

Though obviously light, there is nothing to suggest that the structure is not sufficiently robust for club use, although the Poles use Po-2s or Bücker Bestmanns for *ab initio* training and appeared a little astonished at my suggestion that this could be the role of the Kos in England. The Kos was designed for sports-touring and for teaching aerobatics. There was evidence of this inside the cockpit, access to which is by a rubber-covered walkway and an easy step down into the seat. In deference to its aerobatic capabilities, the demonstrator was equipped with dual control columns, whereas tourers (also aerobatic) have the option of spectacle hand grips sprouting from the panel.

There was adequate room for two in the Kos and the plastic-covered seats were comfortable. Cushions remove to make room for parachutes and both seats have the old pin-and-hole type of Sutton harness. The seats are not adjustable, but the squabs can be repositioned slightly and rudder pedals can be moved through 6½in on the ground by changing the position of a pin. Behind the seats is a luggage compartment extending back to the tail of the canopy. It is equipped with a cat-net tie down and would easily accommodate a weekend suitcase. It was insufficiently deep for Mark Lambert's dog (see page 789) but there was more room on top of the shelf which forms its roof.

The pilot has command of the hydraulic toe brakes and side-panel mounted mixture lever, but in all other respects the Kos has full dual control. Price for price, I thought the cockpit most generously equipped. On the central panel were seven instruments including turn and bank and rate-of-climb indicators; short of a clock and directional gyro there was a full blind flying panel. Central instruments — a compass with course-setting bezel, turn and bank and r.p.m.—are only about 1½in diameter but perfectly easy to read.

Flanking the central panel are, on the left, fuses behind a spring-loaded cover; switches (starter isolator, battery, instruments, generator); a fuel gauge for the 15½ Imp gal tank mounted behind the seats; and a fuel primer. On the right is a pocket into which a Narco Mk V or similar radio could be fitted. There are large access panels for this in the top of the coaming.

Minor controls comprise, left to right across the panel, a push-pull fuel cock, carburettor heat, starter and cabin heat. The knobs are all miniature painted wooden barrels and their attendant controls, although effective and positive, tend to be harsh in operation. To the right of the panel is the elevator trim knob; only an inch in diameter, it is marked by an arrow for neutral and has a range of half a turn in each direction. Control for the split flaps is a wheel between the seats and the flap indicator pokes up through the wing—a system just like the Messenger or the Gemini.

[*Continued overleaf*

In spite of side-by-side seating, span is only 27ft. The power unit is a 90 h.p. Continental C.90-12F with fixed-pitch propeller

PZL KOS IN THE AIR...

(Left) Four toggle fasteners release the alligator cowling and withdrawing another two pins releases it altogether. Translation of wording is "Place propeller horizontal before opening cowling." (Right) Trainers have control sticks, tourers have wheels. This cockpit is discussed on page 791

There was no parking brake, but the toe brakes were adequate for starting. The view downwards and sideways through the big blown canopy was excellent, and it was just possible to see the chocks. On the ground, view was poor directly forwards but, with the canopy open, more than adequate for safe taxying. The differential brakes were powerful and progressive over an unusually long travel; from a brisk walking pace I stopped the Kos—without being too fierce—in about 1½ aircraft lengths.

SP-PAM was equipped with a coarse-pitch "aerobatic" propeller and this was reflected in a rather pedestrian take-off performance. There was some tendency to swing to starboard, but this was easily corrected with a few degrees of opposite rudder. I confess that I was nonplussed by the all-metric instrument calibration and only by converting the figures could I get a true picture of the Kos's performance. Pamiatke Panu, the Polish demonstration pilot, was insistent that I should allow the speed to build up to 110km/hr (68 m.p.h.) after unstick at 85km/hr (53 m.p.h.) and wind in the 10° of take-off flap before attempting to climb. As flap can only be wound off rather slowly, there is no noticeable sink. At full throttle and at this speed, one up, and with about 45 litres (10 Imp gal) of fuel, I measured the rate of climb over 200 metres at 600ft/min. This is well below brochure performance and presumably a measure of the coarse pitch of this propeller.

In the climb just a whisker of rudder was needed to keep straight (the fin has a considerable offset). Stability was positive in pitch and yaw, but the left wing dropped and a slow spiral developed if the stick was not held. I had noticed on the ground that control-circuit friction varied between the surfaces; on the ailerons it was exceptionally low but on rudder and elevators the control remained where it was put. In the air all controls were light and the ailerons particularly so. Response was good in all cases. The rudder looks big and has a long arm, but its power does not seem excessive. I could not induce any short-period oscillations by knocking the stick.

Levelling off as high as the cloudbase would allow I settled into cruising flight at 2,150 r.p.m. at 500m (1,650ft) and 150km/hr (94 m.p.h.). View forward was now good and in all other directions quite splendid. The cockpit is well forward and the canopy frames are almost completely unobtrusive. There is no objection to having the hood open to the first notch—about 3in back—in straight and level flight. The lock is centrally placed in the canopy roof and is easy to operate. There are twin retractable ventilating scoops for fresh air and wire rails for a pair of sun curtains. Noise level was low for this type of aircraft but may be improved on later models with a big wad of sound-absorbent material behind the firewall; at the moment there is no insulation at all. The airframe is not entirely free from engine-induced vibration, but the level is not high. I required to use only about one-tenth of the total trim range during the whole of the flight and in fact the Poles tell me that they ignore it altogether. I'd guess that the heaviest out-of-trim force in any condition is under three pounds. Paradoxically, the Kos has one of the most positive and backlash-free trim systems that I have tried.

Throttling back and approaching the stall very gradually I noticed gentle airframe buffet at 90km/hr (55 m.p.h.) and at 84km/hr (52 m.p.h.) the nose dropped straight and cleanly away. There was no pre-stall pitching. Successive stalls confirmed that ailerons, elevator and rudder each remain effective until breakaway occurs. If the stick was pulled smartly back immediately after stall recovery, the elevator was powerful enough quickly to stall the aircraft again, and a wing could drop. It was easily recovered by rudder and height loss was small. With 10° flap (a hole is drilled in the indicator to denote deflection) stall occurred at 76km/hr (47 m.p.h.) power off and at 70km/hr (44 m.p.h.) power on, but the angle was then unpleasantly steep.

Spins either to left or right were reassuringly easy. Entry was conventional at about 100km/hr (62 m.p.h.) and the spin seemed to develop fully in a direction change of 180°. Rate of rotation appeared to be constant at what—in retrospect—was something like 1½sec per turn, but my height was insufficient for quantitative measurement. After two full turns I applied opposite rudder and recovered in half a turn. Total loss of height was about 200m (600ft); as far as I could judge this performance was repeatable. I did not attempt a reverse-control recovery.

Kos aerobatics are delightful, for although there is not a great deal of power to spare the controls are crisp and light. I found the elevator powerful enough to produce stall-warning buffet in a steep turn with very moderate stick forces and at any speeds the ailerons were a joy. It is sometimes said that ideal control harmonization—that combination of feel and response to stick forces and stick movements—should be in the ratio of 1 : 2 : 3 between ailerons, elevator and rudder. I judged the Kos rudder to be about twice as heavy as the ailerons and the elevator forces about midway between; so the relationship was about right although theoretically on the light side—a situation I wouldn't advocate changing.

After flying the Kos for half an hour or so the numbers on the dial began to make some sense. I tried a loop at 200km/hr (123 m.p.h.), well within the V_{NE} margin of 187 m.p.h. Some rudder was required to keep straight but with all that visibility little effort was involved and the horizon was not lost for long. At the top of the loop, the a.s.i. recorded 70kt. I judged the rate of roll measured through 360° to be 45°/sec and I finished with a series of stall turns—which the Kos does very neatly with no tendency to tuck under.

Back on the circuit I lowered flap below 70kt and checked the power-off rate of descent at 5m/sec (1,000ft/min). There was no perceptible trim change with flap. The descent was fairly steep and view forward good; relatively speaking the flaps are more effective than those of a Chipmunk. I simulated an overshoot by opening the throttle to full power and watching the rate-of-climb needle; it rose rather uncertainly towards the zero mark but was very reluctant to climb higher until I wound off some flap. Performance in this respect would presumably be better with a finer-pitch propeller.

I made a number of landings with the Kos, both on grass and on tarmac. It settled down on three points each time almost of its own accord. A comfortable approach speed with a little power seemed to be about 1.3Vs (say, 70 m.p.h.) and touchdown about 48 m.p.h. Brakes are powerful and the run is very short.

I liked the Kos. It is light, sturdy and feels safe in aerobatics, which it should teach very well. Performance at take-off and on overshoot suggests that more power would be an advantage, and this could also be used to increase the cruising speed of the tourer. For my money, I should like another £50 spent on improving detail finish in the cockpit, which would bring the price to just over £2,500: it is hard to imagine better value than that.

PZL-102B Kos (Continental C.90-12F)

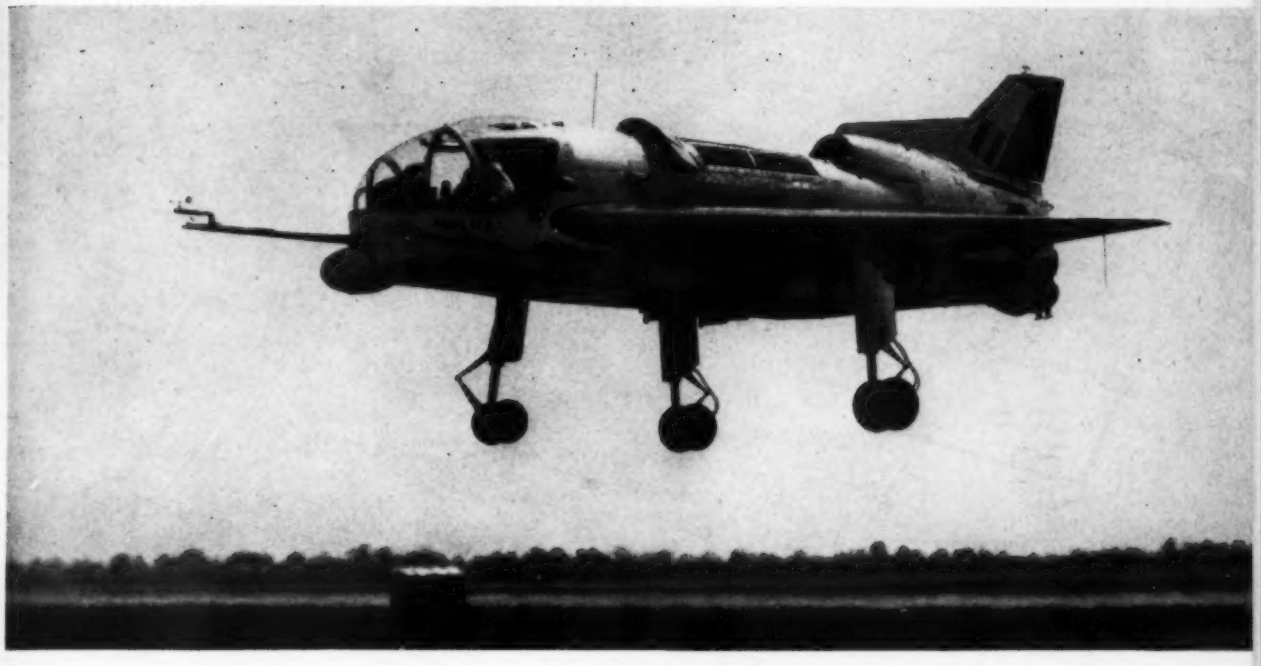
Dimensions: Span, 27ft 10in; length, 22ft 10in; height (tail down), 6ft 2in; wing area, 119 sq ft.

Weights: Gross, 1,390lb; empty, 890lb; wing loading, 11.7lb/sq ft; power loading 14.6lb/h.p.; baggage, 35lb.

Performance: Max speed, 120 m.p.h.; cruising speed, 108 m.p.h.; rate-of-climb, 810ft/min; climb to 3,300ft, 4min 20sec; fuel consumption, 3.8 Imp gal/hr; range at 102 m.p.h., 400 miles; take-off from grass, 566ft; landing from 50ft, 1,100ft.

SC.1

Research into jet-lift by Short's flat-riser



By the Technical Editor

SINCE December 17, 1903, men have been more or less content to fly their aerodynes by the reaction of the atmosphere on fixed or rotating wings, so that the conventional aerofoil is today virtually the sole source of lift in all the aircraft in current operation. In recent years it has been increasingly evident that the gas turbine would gradually open the way to new forms of flying machine in which powerplant and airframe are so integrated that propulsion and lift become merely vector directions of the same thing. The extent to which this integration can be effected is considerable, and aircraft more efficient or versatile than anything hitherto seen can now be drawn on paper and tested in tunnels. Nevertheless, the extent to which jet lift has been applied in practice is very limited. We British may take some pride in the fact that the only fully jet-supported flat-rising aeroplane in the world to have demonstrated complete transition is the SC.1, built in Belfast by Short Brothers & Harland Ltd and powered by five Rolls-Royce RB.108 turbojets.

In truth the SC.1 cannot be regarded as more than a relatively crude and elementary expression of the jet-lift concept; yet it is a vehicle which has already performed unique feats, and as a research tool its value has been very great indeed. Short & Harland produced the SC.1 under contract to the Ministry of Supply, who announced that the company were engaged in such a project (then known as the PD.11) on November 12, 1955. From the outset the Belfast firm have held prime responsibility for the entire aircraft, although collaboration with Rolls-Royce and, on the vital autostabilization and control systems, with the RAE, has been intimate.

Although the programme has never had the priority which it deserves, so that the rate of funding has undoubtedly hampered progress, authorization was made for two SC.1s (XG900 and 905). The first aircraft started taxying trials at Belfast in December 1956, with only the propulsion engine installed. In this configuration the SC.1 could be flown only as a conventional aeroplane—and not a particularly sweet-handling or efficient one at that. Its first flight was made from the main runway at Boscombe Down on April 2, 1957, and the preliminary assessment of the machine as a wing-supported aeroplane was completed here by XG900.

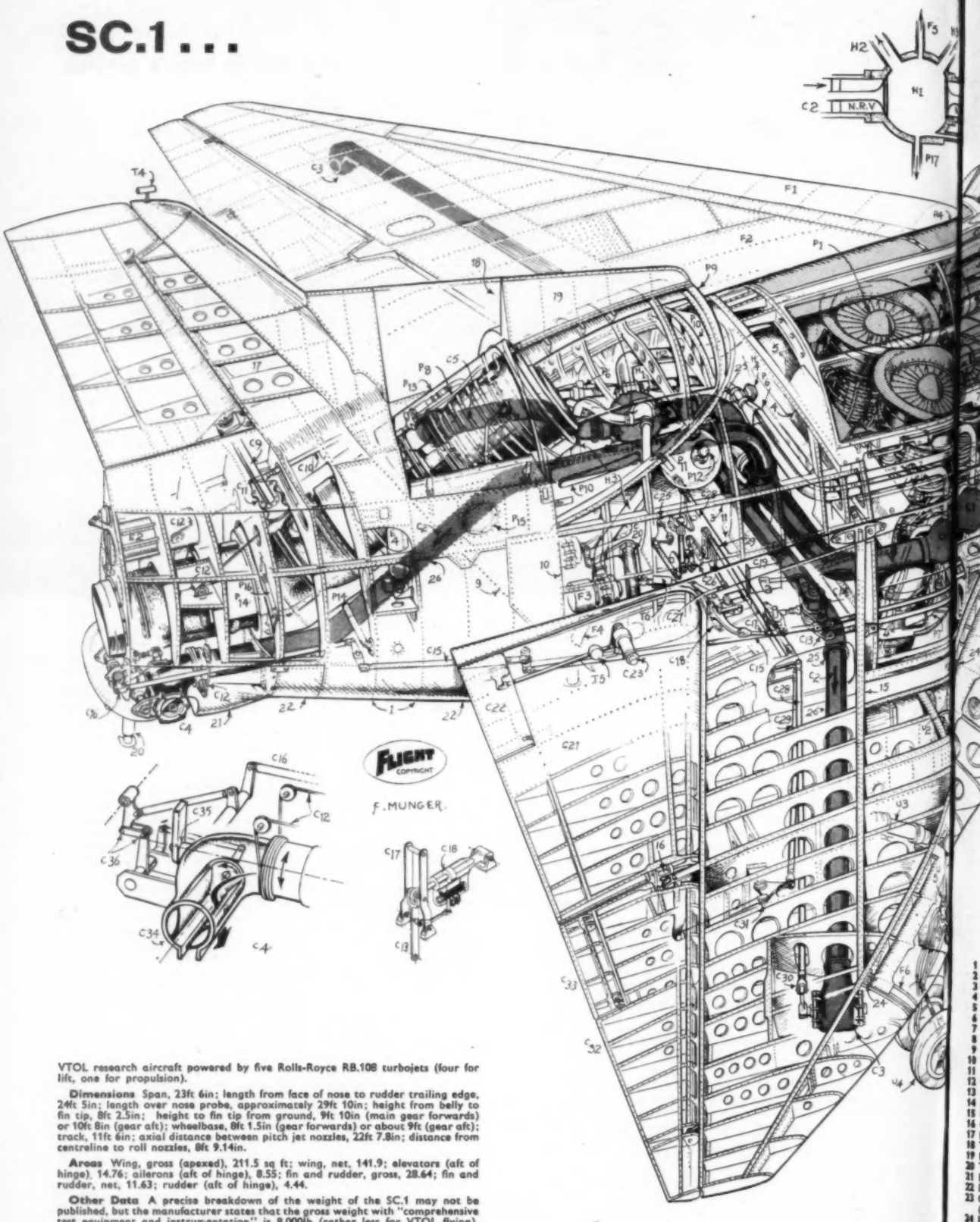
Any piloted vehicle of such unusual character must be evaluated very thoroughly and in the greatest possible number of small discrete steps. Accordingly all the flight characteristics of the lifting and propulsion engines, their relationship with the airframe and the behaviour of the aircraft itself were determined in a painstaking and methodical manner, making the maximum possible use of whatever tunnel models and other techniques could accelerate the programme and reduce its hazards. It was not until more than a year after the first taxying tests that the two pairs of lift engines were installed in XG905. The aircraft was then tethered by cables in a specially designed gantry at Belfast, in which it became jet-supported for the first time on May 26, 1958. During the past two years most of the further exploration of the flight envelope has been conducted by XG905. By November 1958 the aircraft was flying freely as a jet-supported machine, and in that month was even landed (deliberately) on the soft turf of a football pitch.

During 1959, XG905 was provided with a number of refinements preparatory to a new series of flight programmes at the RAE Bedford. At the SBAC flying display in September it provided unexpected evidence of its efficiency as a vacuum cleaner: while operating from the freshly mown surface of the RAE airfield it picked up so many loose blades of grass that its entire lift-engine intake became masked and Tom Brooke-Smith—the company's chief test pilot, who has dominated all the test flying—had to make an abrupt return to earth. Last winter "Brookie" started in earnest on attacking the greatest problem of all: that of transition. By this time the aircraft had been flown extensively in the jet-supported regime up to maximum forward speeds of the order of 40 m.p.h. In addition it had been flown as a wing-supported aeroplane over speeds from some 170kt down to the unaccelerated stall of 134kt. The gap was finally narrowed from both above and below. At the lower end speed was increased in increments of 10kt up to 80kt, checking at each stage that the plenum-chamber pressure above the lift engines was always outside the surge boundary. From the wing-supported regime speed was reduced very gradually from 140 down to 75kt, choosing an altitude band which, while maintaining sufficient height for complete safety, enabled maximum lift-engine thrust to remain comfortably in excess of weight.

Finally the gap was bridged on April 6 of this year, when complete transitions were made both to and from jet-supported flight. Taking off as a conventional aeroplane from Bedford, Brooke-Smith flew round the circuit and lit the four lift engines at 160kt. He then made a long approach to the main runway, gradually

(*Continued on page 796, after double-page drawing of SC.1*)

SC.1 . . .

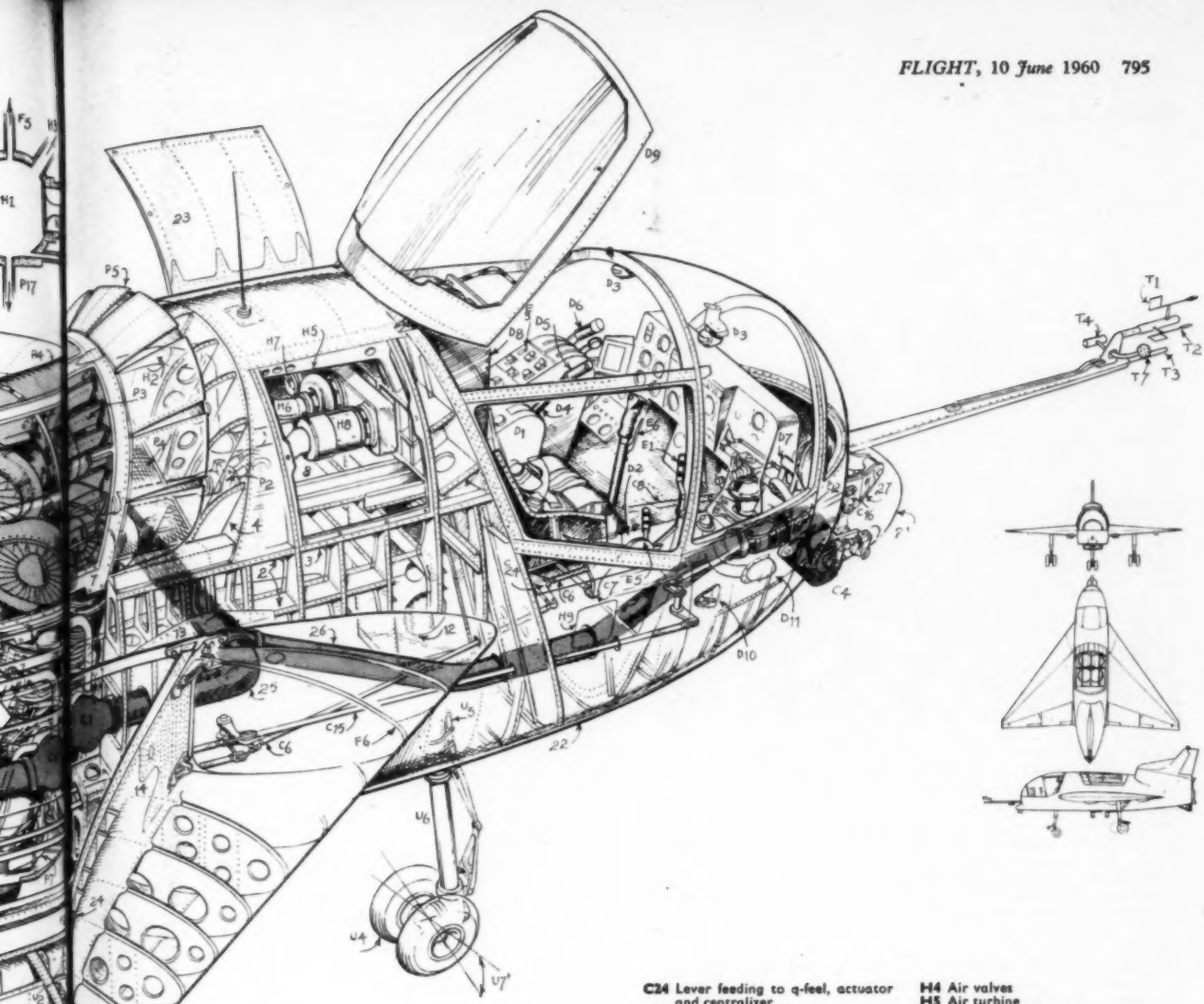


VTOL research aircraft powered by five Rolls-Royce RB.108 turbojets (four for lift, one for propulsion).

Dimensions Span, 23ft 6in; length from face of nose to rudder trailing edge, 24ft 5in; length over nose probe, approximately 29ft 10in; height from belly to fin tip, 8ft 2.5in; height to fin tip from ground, 9ft 10in (main gear forwards) or 10ft 8in (gear aft); wheelbase, 8ft 1.5in (gear forwards) or about 9ft (gear aft); track, 11ft 6in; axial distance between pitch jet nozzles, 22ft 7.8in; distance from centreline to roll nozzles, 8ft 9.14in.

Areas Wing, gross (apexed), 211.5 sq ft; wing, net, 141.9; elevators (aft of hinge), 14.76; ailerons (aft of hinge), 8.55; fin and rudder, gross, 28.64; fin and rudder, net, 11.63; rudder (aft of hinge), 4.44.

Other Data A precise breakdown of the weight of the SC.1 may not be published, but the manufacturer states that the gross weight with "comprehensive test equipment and instrumentation" is 8,000lb (rather less for VTOL flying). The thrust of the Rolls-Royce RB.108s installed in the aircraft is given as 2,130lb, suggesting that the maximum lift available from the lift engines is 8,520lb. The maximum speed of the SC.1 has not been determined but speeds of around 200kt have frequently been attained.



1 Close spaced channel-section frames
2 Box-section side frame
3 Extruded longerons
4 Titanium bulkhead
5 Titanium inner skin
6 Intake guard frame
7 Guard-frame hinges
8 Equipment-bay floor
9 Sloping bulkhead
10 Vertical bulkhead
11 Floor
12 Nose leg mounting box
13 Front-spar fixing (top only)
14 Front spar } sheet web and
15 Main spar } machined L-sections
16 Common elevator/aileron hinge
17 Fin box spar integral with fuselage
18 Top cowling removed
19 Detachable intake for access
20 Tail bumpers
21 Detachable nozzle cowls
22 Detachable bottom panels
23 Glass-fibre equipment-bay doors (port and starboard)
24 Leading edge attachment points
25 Cast light-alloy bends
26 Magnesium-alloy ducting
27 Nozzle and control-levers mounting bracket

Control and stabilization
C1 Air bleed to ring main through engine-mounting trunnions
C2 Bleed air at 65 lb/sq in
C3 Roll nozzle
C4 Pitch nozzle (rotated for control in yaw)
C5 Bleed air from propulsion engine
C6 Pitch-control push/pull rod
C7 Roll-control push/pull rod
C8 Yaw-control push/pull rod
C9 Rudder torque tube
C10 Rudder push/pull rod
C11 Rudder/yaw nozzle quadrant
C12 Cables rotate nozzle for yaw control
C13 Pitch-control input
C14 Pitch-control auto/manual transition unit
C15 Output to pitch-nozzle valves
C16 Push/pull rod to pitch-nozzle valves
C17 Output to elevators
C18 Elevator servo
C19 Pitch autostabilizer
C20 Elevator torque tubes
C21 Elevator
C22 Elevator trim
C23 Trim motor
C24 Lever feeding to q-feel, actuator and centralizer
C25 Roll-control input
C26 Roll-control auto/manual transition unit
C27 From roll autostabilizer
C28 Output to roll-nozzle valves
C29 Output to ailerons
C30 Push/pull to roll-nozzle valve
C31 Push/pull to aileron
C32 Aileron
C33 Aileron balance tab
C34 Valve
C35 Pivot
C36 Self-aligning bearings

Cockpit
D1 Port console
D2 Starboard console
D3 Compass units (E2B)
D4 Lift-engine power
D5 Propulsion power twist-grip
D6 Propulsion power lever
D7 Toe brakes
D8 Lightweight Martin-Baker ejector seat
D9 Entry and escape hatch
D10 External canopy release
D11 Cooling air

Emergency systems
E1 Canopy jettison
E2 Braking-parachute stowage
E3 Parachute stream and jettison
E4 Fire bottle No 1 zone only
E5 Engine-tilt emergency lever
E6 Emergency brake

Fuel
F1 Detachable rigid leading-edge tank
F2 Bag-tank cell
F3 Turbine-driven h-p. fuel pumps
F4 Turbine exhaust
F5 To fuel recuperator
F6 Tank end

Power systems
H1 Distributor, auxiliary air system
H2 Air to air turbine, auxiliary gearbox
H3 Air to air turbine, fuel pumps
H4 Air valves
H5 Air turbine
H6 Air-turbine exhaust
H7 Hydraulic pump
H8 Generator 24V
H9 Ground-supply socket

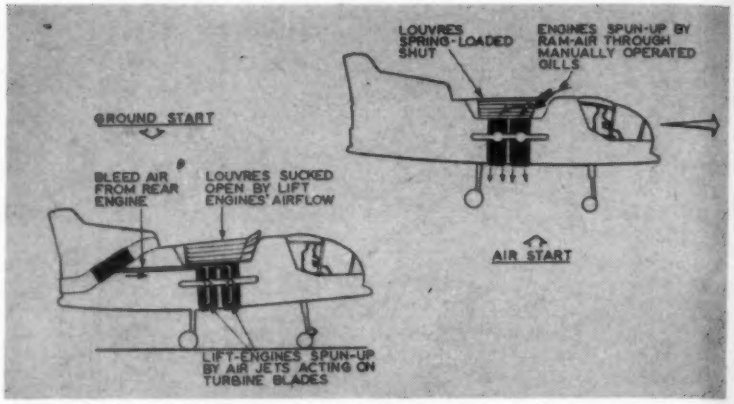
Powerplants
P1 Lift engines, paired RB.108s (shown slightly tilted)
P2 Engine-tilt jack
P3 Intake louvres, spring closed, sucked open
P4 Wire-mesh screen
P5 Manually operated intake gills
P6 Lift-engine starting air bled from propulsion-engine
P7 Lift-engine starting air to turbine impingement
P8 Propulsion RB.108 engine
P9 Intake
P10 Boundary-layer bleed
P11 Oil tank
P12 Oil-tank filler
P13 Engine shroud
P14 Jetpipe shroud
P15 Engine-mounting access
P16 Jetpipe sling
P17 Rear-engine-bay vent air } detail only
P18 Oil-tank pressurization } detail only
P19 Atmospheric bleed

Test equipment
T1 Yaw-meter vane
T2 Angle-of-attack vane
T3 Pressure head
T4 Venturi
T5 Potentiometers
T6 Torquemeter
T7 Static pressure

Undercarriage
U1 Two-position main leg
U2 Main-leg pivot
U3 Drag brace and positioning jack
U4 Fully castoring wheels
U5 Castoring lock for conventional take-off
U6 Long-stroke (22.4in) oleo
U7 Rocking axle to accommodate 360° castoring
U8 Leg forward position

SC.1 . . .

decelerating and progressively transferring the burden of supporting the aircraft from the wing to the lift engines. Complete transition was accomplished at a height of 100ft, but Brooke-Smith continued to descend at zero forward speed until the aircraft was hovering 20ft above the intersection of the runways. Then to complete the sequence the aircraft was accelerated forwards, using both the lift and propulsion engines, and translated back into normal aeroplane flight. Brooke-Smith climbed back to the circuit and finally landed conventionally. Some 20min were spent in the air on this occasion.


LOUVRES SPRING-LOADED SHUT
ENGINES SPUN-UP BY RAM-AIR THROUGH MANUALLY OPERATED GILLS
GROUND START
BLEED AIR FROM REAR ENGINE
LOUVRES SUCKED OPEN BY LIFT ENGINES' AIRFLOW
AIR START
LIFT-ENGINES SPUN-UP BY AIR JETS ACTING ON TURBINE BLADES

At high forward speeds the lift engines may be turned by ram air taken in at the gill intake. At lower speeds, or with the aircraft at rest, all engines may be brought to speed by air impingement jets which act directly on the turbine rotor blading

THE AIRCRAFT DESCRIBED

In the design of the airframe Short and Harland had merely to provide an envelope capable of accommodating the four lift engines, single propulsion engine, pilot ejection seat, fuel and instrumentation. A wing of relatively small size was necessary, together with an undercarriage of somewhat exceptional character and a stabilization and control system capable of governing the aircraft at all forward speeds down to zero. The final stipulation was that the weight should be reduced to the lowest possible level.

Structurally the SC.1 is relatively orthodox. The stumpy fuselage is built up from channel-section frames spaced at the close pitch of about 7in, together with stringers attached to the skin. In the extreme nose is the large cockpit, providing the pilot with an unsurpassed view. The Martin-Baker Mk V4 ejection seat is carried on rails on the sloping rear bulkhead, on the reverse face of which is a box structure to which is attached the nose leg.

The entire dorsal and ventral portions of the centre fuselage are cut away to accommodate the four lift engines. The latter are mounted in trunnions on deep axial box beams which take the end loads. The fore and aft limits of the engine bay are determined by bulkheads which slope outwards above and below the wing spars—to which they are attached—in order to permit the two pairs of lift engines to be pivoted about their lateral axes. All round the engine bay an interior skin of titanium sheet is provided to increase fire resistance. The rear fuselage accommodates the inclined propulsion engine, fed from a dorsal intake, and is constructed integral with the fin.

Unusual in that its design was not dictated in any degree by low-speed performance, the wing is a true delta with a root thickness/chord ratio of 10 per cent. Leading-edge sweep is 54°, the rear spar lies normal to the fuselage axis and the front spar is at 30 per cent chord. Most of each leading edge is sealed to accommodate fuel and is secured to the front spar by quickly detachable tongue-and-fork fittings. Bag tanks are fitted between the spars. To the trailing edges are hinged conventional elevators and ailerons, but flaps were not considered a requirement.

Although the SC.1 is most unusual among jet aircraft in having a fixed undercarriage, the alighting gear posed singular problems and is less simple than it appears. Each of the cantilevered legs carries twin wheels, those of the main gear having pneumatic disc brakes. Short's own precision engineering division produced the gear, using wheels, tyres and brakes by Dunlop.

Each main leg is hung from a light alloy forging attached to the wing by a single pin. The drag brace is a hydraulic jack which can position the leg either in a forward position for normal flight or sloping rearwards for vertical landing. Should the pilot land vertically with the wheels in the forward position there is a slight risk that the aircraft might be blown over backwards. The twin wheels are coupled to a live axle and are arranged to castor freely when the leg is in the rearward position during vertical take-off and landing. With the leg in the forward position a hydraulically actuated lock holds the axle rigid in azimuth. Inside the leg is a cam mechanism which centres the leg through $\pm 180°$ so that, even if a landing is made backwards with drift, the wheels will centre again as soon as the aircraft taxies forwards or takes off. The nosewheels are likewise dogged to a live axle, and are free to castor during vertical landings. In addition the axle has limited freedom to rotate about a fore-and-aft axis, to keep both wheels firmly on the ground even when the aircraft is not laterally level.

Powerplants From the outset the SC.1 was designed to mount five Rolls-Royce RB.108 turbojets, one in the tail for propulsion and four in the fuselage centre section for lift. The RB.108 is still partly cloaked in security, but it is clearly one of the great family of small turbojets of high thrust/weight ratio which started seven years ago with the RB.82 Soar. Unlike the earlier engine, the RB.108 is not fabricated from sheet but has a conventional machined compressor casing. Nevertheless, it is an extremely simple powerplant, with a minimum of control and accessory systems. Rated thrust is usually 2,010-2,130lb.

In general the propulsion-engine installation is conventional, apart from the fact that the axis of the engine is inclined to make up the difference in level between the dorsal intake and the central propelling nozzle. The lift engines are installed approximately vertically in two pairs. The two engines of each pair are rigidly held together by links on the compressor outlet casing, and the complete package is then supported on trunnions providing freedom of rotation about a transverse axis. Both pairs of engines are joined by a pivoted link and all four are then positioned through 30° either fore or aft of the vertical by a slow-moving linear jack ahead of the first pair.

Each engine is controlled by a simple mechanical system which includes a starting air valve, throttle and h-p. cock for shut-down. Lift-engine controls are grouped to a single lever reminiscent of helicopter collective-pitch. To the end of this lever is a twist-grip for the propulsion engine, although the latter is normally governed from a conventional power lever on the port console. To stabilize and control the aircraft at low forward speeds a system of air jets is employed, using air bled from the compressor outlet casing of each engine. When the lift engines are started with the aircraft at rest, excess compressor air is dumped overboard through the stabilizing system in order to prevent compressor stall. Each dump valve is spring-loaded towards the closed position and is opened pneumatically from a cockpit control.

Occupying the whole dorsal part of the centre fuselage, the lift-engine intake is guarded by wire mesh and contains a series of longitudinal louvres. The latter are pivoted at their ends and spring-loaded so that they normally assume the closed position, each louvre mating accurately with its neighbours to present an unbroken dorsal surface in conventional flight. When the lift engines are started, the consequent depression in the plenum chamber above them is sufficient to pull the louvres open and provide an uninterrupted intake. Forward of the louvred area is a forward-facing system of retractable gills which are normally open whenever the lift engines are running. The gills are closed during aeroplane flight; when the lift engines are to be started in the air the gills are wound open manually and the ram pressure thereby created in the lift-engine bay assists in spinning up the lift engines to self-sustaining speed, the positive pressure holding the louvres tightly closed.

Autostabilization and Control For use during aeroplane flight a conventional flying-control system is provided. Push/pull rods are led to the rudder, ailerons and elevators, the last-named being provided with irreversible power units with manual reversion. Each elevator has a trailing-edge tab, that to starboard being an electrically actuated trimmer and the port tab being a balancing surface operated automatically.

At low forward speeds stabilization and control of the aircraft are effected by two pairs of downwards-facing air nozzles, one pair being located beneath the outer wings for control in roll and the other being located at the extremities of the fuselage to provide control in the pitching plane (and, by sideways rotation, in yaw also). Air for this system is tapped from the compressor outlet casings of the four lift engines, the pressure at maximum r.p.m. being 65lb/sq in. The air is passed through the outboard lift-engine trunnions and thence through a central gallery to the main distribution ducts. The latter are formed in magnesium alloy, sealed by O-rings to cast light-alloy bends secured to the airframe. All four nozzles are normally partially closed, the control action being produced by differential opening and closing of the two members of each pair.

SC.1 . . .

Two transition mechanisms permit the pilot to select any of three states: fully manual, with direct control of both the surface controls and the nozzles; nozzle-stabilized, in which the surface controls are moved manually and the nozzles are independently controlled by an autostabilizer; and fully stabilized, in which the autostabilizer operates both the nozzles and surface controls (control in the yawing plane alone remaining manual, the cockpit pedals governing the rudder and rotation of the pitch nozzles). A synthetic-feel unit is incorporated in the elevator power system, and the ailerons are provided with a small spring-feel unit to supplement the normal aerodynamic feedback.

One of the few areas of the SC.1 still subject to security classification is the autostabilization system. In its development Short's precision engineering division at Castlereagh co-operated closely with the Royal Aircraft Establishment, and both organizations conducted a great deal of fundamental research to produce the desired results. It may be recalled that the precision engineering division have developed a number of advanced types of simulator (certain analogue models being commercial products), and have also developed the fully automatic control system of the Canberra U.10 target aircraft. The SC.1 autostabilizer is controlled by a triple hydraulic servo. All three jack units are rigidly connected, and by-pass ports enable a faulty unit to motor freely so that the majority rule can preserve control. The four-way control valve is operated by a Laws-relay transducer.

Accessories In view of the lightweight nature of the RB.108 engine, accessories requiring shaft-power are mounted on an accessory gearbox driven by an air-turbine running on compressor bleed air. A hydraulically operated pneumatic throttle regulating system maintains accessory r.p.m. over a range of air supply pressures. Turbine failure is signalled to the pilot to warn him to fly manually.

In many respects the hydraulic system is unusual. Operating on mineral OM-15 fluid at 2,500lb/sq in it serves the autostabilizer system, elevator power unit, control nozzle servos, feel system, transition mechanism and lift-engine tilting. The electric system is energized by a 24V, 25A-hr battery charged by a 28V d.c. generator. A Venner 60A-hr battery is provided for emergency use, and a pair of inverters, with a third as standby, serve the autostabilization system and instruments. The pneumatic system, energized from three spherical bottles mounted on the rear of the cockpit bulkhead, serves normal and emergency brake operation and the emergency operation of the transition mechanism.

Flying Techniques The foregoing provides an outline of the major features of this most unusual aircraft. It is appropriate to conclude with a brief outline of the manner in which the aircraft is flown in practice. Full performance characteristics may not yet be published, and accordingly quantitative information must be given in general terms only.

Entering the SC.1, the pilot has to use a ladder, usually to port of the forward fuselage, and opens the entry hatch. Originally the canopy roof hinged at the rear to form an emergency exit, and incorporated a forwards-hinging entrance hatch. Today, the entire roof is glazed and frangible, and is hinged along its rear edge to fulfil both functions. View from the cockpit can best be described as "similar to that of a helicopter." The pilot has a conventional pistol-grip control column and rudder pedals; instrument panels are located relatively low, to improve forward view, and engine and electrical controls are respectively grouped on consoles to port and starboard. The unpressurized cockpit is ventilated by a punkah louvre on the starboard side, fed from a nose intake, and an extractor is fitted at the upper, right, rear.

Ground electrics are plugged in on the starboard side of the forward fuselage. To start the propulsion engine a pneumatic line is attached to the port side of the rear fuselage from a battery of air bottles. The air is passed at 75lb/sq in to a jet impinging directly on the turbine blading, and the RB.108s run quickly up to speed. Then the lift engines may be started by bleeding air from the propulsion engine to each one in turn. For the moment, however, one can assume that the aircraft is to take off conventionally.

Using the propulsion engine only, the aircraft taxies out using differential wheel brakes and lines up on the runway. Any of the three modes of control may be selected, and for a conventional take-off it would be feasible to operate the surface controls in the manual mode. The main legs are in the forwards position and the lift-engine gills and louvres shut. Using the lever on the port console, the propulsion engine is opened up to full power and the aircraft takes off at a high angle of attack at about 140kt and climbs away.

At a suitable height the lift-engine gills may be opened and the four RB.108s brought into action. From this point on, the aircraft can be flown almost as a helicopter, the stick behaving as a cyclic-pitch control and the lift-engine throttle as a collective-pitch lever. To bring the aircraft to hovering flight it is necessary to shut down the propulsion engine and then move the lift-engine-tilt switch on the control column in order to give a negative thrust component. The effect of tilting the lift engines is exceedingly powerful, and it is most unlikely that a tilt angle greater than −15° will be chosen. At the same time the nose of the aircraft is brought up to a maximum of about 10° to help the aircraft lose speed while maintaining altitude. This is almost the only significant attitude change in normal flying.

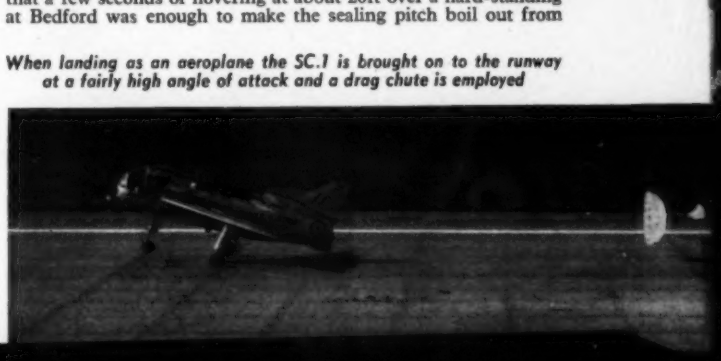
Pilots who have flown the SC.1s include Jock Eassie and S/L. Hubbard; but nearly all the work has been done by Tom Brooke-Smith (above), chief test pilot of Short Brothers & Harland Ltd

Tom Brooke-Smith can bring the SC.1 to a standstill from 140kt in about 400yd. The attitude of the aircraft and/or the lift-engine tilt may be determined by the wind strength and direction, but it is possible with practice to hover motionless over any given point. The control system is exceedingly potent. When hovering, stabilization would probably be used to govern both the surface controls and roll and pitch nozzles. The autostabilization system has approximately five times the power of a conventional autopilot, and a runaway could prove catastrophic (on the pitch axis, for example, a runaway would turn the aircraft upside down within 2sec). It is for this reason that the circuits are all triplicated to provide majority-rule safety.

To translate back into aeroplane flight, the lift-engine-tilt switch is moved to give 15° positive inclination and the propulsion engine opened up once more. Forwards acceleration is comparable with that of a modern fighter's take-off—in fact the process appears much like a conventional take-off except for the fact that the aircraft is not on the ground. Aerodynamic controls take effect at about 30kt and at around 140kt the lift engines can be shut down and the dorsal surface returned to the "clean" condition. Landing conventionally the aircraft is brought in fairly fast, touches nose-high and is brought to rest with the assistance of the braking parachute, which is streamed electrically from its box above the propulsion-engine nozzle.

When operating in the complete VTOL role Short & Harland have flown the aircraft from a 40ft-square metal platform, some 12in off the ground, with a central octagonal hole about 8ft across which accepts the blast from the lift engines. Without such a platform operations are exceedingly difficult. Last week *Flight* noticed that a few seconds of hovering at about 20ft over a hard-standing at Bedford was enough to make the sealing pitch boil out from

When landing as an aeroplane the SC.1 is brought on to the runway at a fairly high angle of attack and a drag chute is employed



Transition sequence: these photographs of a vertical take-off and transition were secured recently at the RAE Bedford during trials with XG905

The chocks seen being pulled away in the first picture above are employed during engine starting. The aircraft is operating from a metal platform

SC.1 . . .

between the slabs of concrete; and hovering over any loosely compacted surface is spectacular, to say the least.

Rolls-Royce are currently engaged in a detailed survey of ground blast patterns with a lift engine mounted vertically in a Meteor fuselage. Where the operating platform permits, the best technique appears to be to hold the lift engines at a reduced idling speed and accelerate the aircraft forwards to about 25 m.p.h. in order to break through the ring of hot gas and dust. As soon as the aircraft has reached clean air the lift engines can be opened up fully and the aircraft climbed out almost vertically. When hovering near the ground the SC.1 creates an undesirable hot environment with a radius of some 30yd, which reduces lift-engine thrust (by raising intake temperature) and will cook the tyres in 90sec.

Short & Harland have so far spent rather more than £2m on the complete programme. This sum, which is naturally recoverable under the terms of their MoA contract, appears exceedingly modest in view of the great problems solved and the solid experience gained in what may prove to be a most valuable type of flying machine. The most obvious and immediate application of the arrangement is in tactical strike aircraft, and there is already a NATO requirement for such a machine. The only aircraft known to be under development for such a role are the Hawker P.1127 and a project being designed principally by Messerschmitt. The P.1127 has a single dual-purpose Bristol Siddeley engine and thus falls into a somewhat different category. The West German machine is of a more advanced nature, having a top speed unofficially said to be M3 and using six Rolls-Royce RB.153 turbojets mounted on gimbals for lift and propulsion. The British Minister of Defence has already suggested that it may become a standard RAF type, and it is certain to figure prominently in the joint British/German/French/Italian discussions of VTOL aircraft taking place.

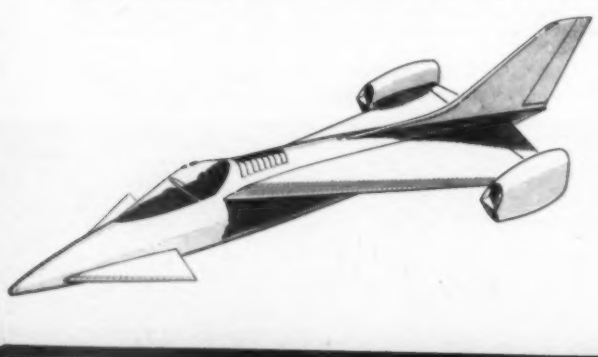
Nevertheless the project is still in an embryonic stage, and the German consortium are hardly strong enough to progress rapidly by themselves. Short & Harland have, to use the vernacular, "got their feet wet," and it would be indeed strange if their extensive fund of jet-lift knowledge were not to be utilized. Last year a Messerschmitt team investigated the SC.1 programme, but no international agreement has been hinted at, beyond the Minister of Defence's disarming assertion that "If we bought the German VTO aircraft there is no reason why it shouldn't be built in this country as well as in Germany." Only the powerplant firms, Rolls-Royce and MAN, have reached a deal, on their own account, for the RB.153.

No details of the RB.153 have yet been divulged, although it is said in France to have a thrust of 4,960lb and according to British reports has a thrust/weight ratio of 16 : 1 (higher than that announced for any other turbojet), said to be achieved partly by widespread employment of glass-fibre and other reinforced plastics for cool portions of the structure. This powerplant has been chosen by Short & Harland for a number of design studies. Such a machine would have supersonic capability but would spend most of its life at around M0.9 at low altitudes. The dead weight in cruise of the lift engines would be largely, if not entirely, counteracted by the diminutive size of the wing, rudimentary undercarriage, reduced drag, need for less diversion fuel, and by several other factors. Aircraft of this type could be deployed in quantity in seven to eight years. It is Short's view that the stabilization system would account for some 18 per cent of the cost of any aircraft of this type. One Short study is portrayed below.

Short & Harland are also very interested in what the principle could do to make a supersonic airliner more attractive. Such a machine is still obviously a long way down the road. In fact, it has not yet been proved that a VTOL supersonic airliner of the Griffith type would be economical; but Short's technical director (author of the narrative which concludes this account) has "a strong hunch" that it would. The company are convinced that the larger and faster such an aeroplane can be made the better it will be.

By far the worst problem would be that of noise, for the SC.1 is as noisy as any aeroplane of its size in the world and the problem would not diminish with increasing power. One advantage would be that on take-off the perceived noise level would decrease rapidly, since studies suggest that an M3 Griffith-type transport would reach 1,200ft at the same point on the runway that a typical modern transport reaches 125ft. Noise on the approach might be more severe, since a normal minimum gradient before landing would be 10-12° There is, however, the possibility that such a machine could fly a fixed airfield pattern, independent of wind direction, so that the worst noise would always be experienced in the same area. A final favourable point would be that from the outset its control system would be suitable for truly automatic flight in all weathers.

This suggested VTOL strike machine has four tip-mounted dual-purpose engines, supplemented by a battery of lift engines in the forward fuselage. The intake for the latter may be seen behind the canopy



The Development of the SC.1

By H. G. CONWAY, Joint Deputy Managing Director and Chief Engineer, Short Bros & Harland Ltd

IN some respects the development of the SC.1 has been similar to that of a guided weapon. By this is meant that the engineering team has had to comprise a variety of specialists embracing techniques more likely to be found in a guided weapon firm than in a conventional aircraft unit. Insofar as a small delta aircraft may be considered conventional, there is nothing very unusual about the structure. Nor was the aerodynamic development of the aircraft itself unusual except in respect of the new VTO problems. What has, however, involved a major development programme and indeed a very interesting integration of different engineering experience and skill has been the design and development to a satisfactory stage of the VTO control system as a whole. The original proposals, made in early 1954, were that Shorts should develop the airframe and that RAE would develop the automatic control equipment, based on that which had been produced by them for the Rolls-Royce Bedstead. It was soon apparent that Farnborough could not provide the major effort required to do this and that Shorts should set up a team to carry on with the good work which the RAE had started.

The basic principle on which the autostabilizer was developed was initially the same as that of the Bedstead in terms of the "control equation." Later, as a result of a considerable amount of simulation work at Belfast, this was changed. It was found possible to simplify the system for conventional daylight operation as has been demonstrated very satisfactorily recently. A new approach has, however, been needed for the ultimate semi-automatic or fully-automatic blind landing objective which is ahead of us and is being worked on at the moment.

The initial and fundamental contribution of Shorts in this field, made in 1954/55, was to make the case for, and to devise, a triplicated system to give a level of safety which the firm considered was not adequately achieved by the duplicated system of the Bedstead. It was here that the specialized team which Shorts had at their Castlereagh factory, engaged on missiles and computer development, made a notable contribution. A hydraulic servo had been chosen to get adequate response (as compared with the electric servos on the Bedstead). The risk of a seizure in the central position of the small hydraulic valve in one channel (which could risk blockage of the whole servo) was originally accepted as extremely unlikely. Later, however, as a result of an incident on one of the Bedsteads, Shorts were asked to devise a means of signalling the correct response of these miniature valves. No one had done such a thing before, bearing in mind that the movement of the valves is measured in tenths of thousandths of an inch. The team might have made a case for not doing this and for continuing on a calculated risk basis had it not been for the publication of a firm's Research Department report on the development of a miniature and highly sensitive pick-off which some bright young engineer thought could be used for this purpose. Naturally this report was seized on by the MoS as indicating that a solution was possible, and inevitably the firm were then committed to its development. It is common knowledge in the aircraft world that the development of small devices of this type is not easy and can take time and, in fact, about twelve months passed before the system could go from the laboratory to the reliable flight stage.

There have been many similar, although perhaps not so difficult, problems of technique to solve. The technical policy of the company has been, as far as possible, to develop equipment itself, because it felt technically competent to do so and preferred the close co-ordination which could be achieved by grouping different teams under unified control. Development problems which were solved, included, for example, the design and development of pneumatic nozzles. This involving the building of a hot-gas generating system, to get representative pressures and temperatures, and the testing of several different types of nozzle before a satisfactorily efficient and non-seizing design was devised; the development of manufacturing techniques for automatic welding of ducting; the design of a completely novel type of undercarriage with friction-free characteristics, since friction on leg extension was known to prevent the aircraft from taking-off level; the engine-tilt control system, with automatic emergency centering; a transition mechanism which would allow the controls to be coupled or uncoupled as required in different modes; an autostabilizer gyro control unit, including manufacturing development of magnetic amplifiers, printed circuits, transistorized circuits, AC pick-offs, electro-magnetic torque motors and high-precision miniature hydraulic servos—all having to be specially designed for the aircraft. In parallel, an aerodynamic team was learning how to handle the specialized problems of the engine installation and ground suction and recirculation problems. This meant designing powered wind-tunnel models which could give the correct representation of the airflow into and out of the fuselage, which was fundamental to satisfactory tunnel testing.

What is the immediate programme? Clearly we have demonstrated that the engineering installations on the aircraft are such that reliable and easy transitions are possible and that jet-lift vertical take-off and landing is a practical proposition. This was the fundamental purpose of the development programme and therefore we can claim to have achieved what we set out to do. Although it may not have been a clear objective when we started, it is true that a result of this work is the development of a control system immediately suitable to operational aircraft. However, although we have carried out over forty transitions in both ways in a few weeks, we still have a lot of work to do to optimize the technique with the particular objective of minimizing fuel consumption. This will mean extended trials under different flight envelopes.

We have demonstrated that the operating platform we have devised after a great deal of difficult test work is entirely practicable and that because of the precision of control of the aircraft nothing larger or more complicated is required. Obviously, for civil applications a built-in platform or pit along these lines is quite practicable and would not present any difficulty to an airport authority used to laying millions of cubic yards of concrete. But in the tactical military role it could be highly desirable to eliminate even a platform of this size. We are hopeful that by suitable take-off technique it will be possible to take the aircraft off in a few yards by opening the lift engine throttles as the aircraft moves forward. This might mean that the aircraft can get off the ground in a short run of fifty or sixty yards of roadway, although this is not to be confused with STOL in three or four hundred yards. Much work will be done in forthcoming months on this problem.

A substantial programme of work on automatic devices is continuing at Belfast, initially to give automatic transition between jet and aerodynamic lift, and new stabilization equipment is coming along which will be suitable for full blind landing. Shorts feel strongly (and the MoA are supporting the work) that VTO without all-weather operation is not sensible, since the ability to operate under any conditions is vital to the use of tactical military aircraft and even more so to the proper development of civil transport.

The idea of flying to New York in a couple of hours and having to come back because you cannot land is absurd. The idea of landing at New York in a conventional supersonic aircraft at an approach speed of 180 m.p.h. on a $1\frac{1}{2}^{\circ}$ approach path on an automatic blind landing system is terrifying to some of us. In either case, there must be reliance on automatic equipment of comparable levels of complexity. But one system is geometrically sensible and the other nonsensical—at least to some of us!

In March 1959 the Prime Minister discussed the company's military VTOL ideas with (from left) H. G. Conway, Frank H. Robertson (now chief designer, light aircraft division) and Rear Admiral Sir Matthew S. Slattery (chairman)

Is Australia's Aircraft Industry Doomed?

TODAY'S BLEAK OUTLOOK

UNLESS—as now seems unlikely—the Australian Government orders its new supersonic fighters in numbers sufficient to make local production a feasible project, the Australian aircraft industry as we now know it is doomed.

The RAAF is now making it plain to the politicians that it does not like the idea of being tied to local production. But this is not a new development. The last Chief of Air Staff who was absolutely for the local industry was Air Marshal Sir George Jones (1942-50). He had good reason. The Allied committee which allocated aircraft to various theatres of war so starved the RAAF that it is an historical fact that but for local production of Beauforts, Beaufighters, Boomerangs, Tiger Moths, Wackett Trainers and Wirraways the RAAF would have been grounded in 1940-44. The Empire Air Training Scheme would have been seriously hampered without Australian participation.

This created a tremendous impression on the RAAF of the post-war years and the production of Mustangs, Lincolns, Vampires, Canberras and Avon-Sabres was a direct result. During the war aircraft could be produced on a basis competitive with overseas costs—Wasp engines were actually built in Australia at some 70 per cent of the American production cost. In 1940-45 the local industry delivered 3,500 aircraft and 2,850 engines to the RAAF, including 700 Beauforts, 329 Beaufighters (35 more were made after the war), 200 Wackett Trainers, 250 Boomerangs, 620 Wirraways and 1,035 Tiger Moths. By 1948 the Mosquito deliveries had totalled 228. The post-war RAAF of the 1940s and early 1950s literally flew with Australian-built aircraft—Mustangs, Lincolns, Vampires—and the replacements were local Avon-Sabres, Canberras.

Some heart-searching was needed before the all-American Lockheed Neptune P2V-5s were ordered; it was carefully explained that the order was too small to suit local production. Even when the Lockheed C-130s were ordered there was a good deal of discussion in trade union circles about the "surrender of the industry."

Delayed Delivery

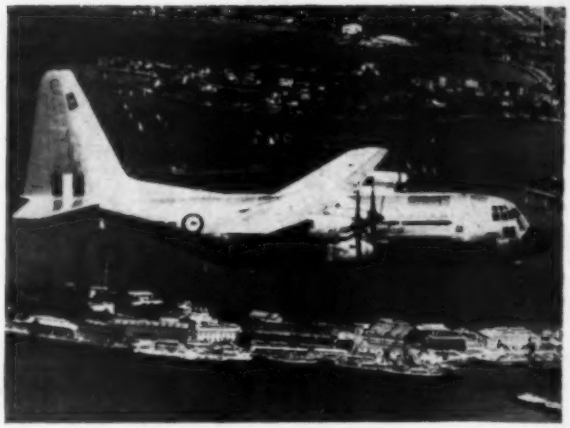
Today's RAAF leaders are not so enthusiastic about the local industry, partly because of the time taken to get the Avon-Sabre into service, partly because of the fact that orders are so designed that the factory concerned will get the maximum period of production. The factory wants the smallest possible delivery rate, in order to extend the order as far as possible. In the case of the Avon-Sabre, the RAAF chafed under the slow delivery, which made the aircraft obsolete by the time a full wing was operationally equipped.

Today the industry is in a frankly hazy state. Commonwealth Aircraft Corporation is down to absolute bedrock, beyond which it must close down. It is producing the last of the Avon-Sabres of the supplementary order given to CAC under RAAF protest several years ago. The RAAF did not need the extra aircraft; the order was simply made as a political gesture, to save the Corporation going out of business. If CAC does not get an order within the next year, it must close down.

The RAAF mission going abroad (as this article is written) to evaluate supersonic fighters has Ian Fleming, a veteran of the industry (though now Controller of Aircraft and Guided Weapons Supply in the Department of Supply) to advise on the production aspect of the various types.

Now, however, it is generally understood in Australia that the intention is to place a much smaller order for fighters than was originally thought likely. The RAAF simply cannot afford to order four squadrons of supersonic fighters and follow this quickly with a supersonic-bomber order. The result will probably be an order for two squadrons (under 50 aircraft) of fighters and one of bombers. This is not a practical proposition for local production.

There is a strong feeling in the RAAF—as there has been for some years—that operational capability has been crippled since the war by the necessity (basically political) of maintaining a local industry. The pressures come from the industry itself, the trade unions, and bitter memories of war years of aircraft scarcity. The Service has always had to wait for delivery of aircraft from local factories, not because the industry could not make the aircraft quickly, but because slow delivery kept the industry in business. Further—and here conditions have changed since the war era mentioned above—the RAAF feels it has had to subsidize the industry at its own expense. The Royal Australian Navy always refused to buy its aircraft locally. The Air Force alone bought local aircraft, at two or more times the imported cost. It feels it could be twice as strong if it did not have that dreadful economic drag. The possibility of the Government itself subsidizing the industry outside the Air Defence Vote is not politically feasible. The RAAF simply goes on subsidizing the industry out of its £50,000,000 a year total vote.



"Even when the Lockheed C-130s were ordered there was a good deal of discussion about 'the surrender of the industry.'" One of these aircraft is seen over Sydney Harbour

There is no question of producing a bomber. The Government Aircraft Factory is now completely devoted to the Jindivik and other enterprises of that sort. The only types which might be produced in Australia are fighters and trainers. All attempts to interest the airlines in local aircraft have failed—the de Havilland Drover three-engined feeder bush airliner was sold to TAA and Government Departments because the Government said it had to be.

All three fighter types under serious consideration could be proproduced locally. All three companies under consideration—Dassault, Northrop and Lockheed—have told the Government they are keen on Australian production, partly because they realize there would probably be a larger order for local production than for imports.

In the trainer field, de Havilland Aircraft Pty Ltd are just completing an order for 62 Vampire Trainers. They will then have only overhauls and maintenance to do. Under Wg Cdr Rollo Kingsford Smith, who has recently been appointed manager of the aviation division and a director of the company, they have extended their interests to representation. They are vigorously pushing the Beech series and they are deep in the sales and even production of aluminium boats. Their jet-engined boat has great promise.

The only aircraft order which could be given to the Australian de Havilland company is for the jet primary trainer. The RAAF do not, however, regard this requirement as a priority. I understand it is now unlikely that they will order such a trainer for several years. The money simply is not there. As de Havilland have the Provost representation, they were naturally interested. It should be remembered, by the way, that the DH Australian company is specifically left out of the British rationalization agreement. Whatever happens in the UK, the Australian firm remains independent as a local organization.

So at the moment of writing it seems there is no hope for the Australian aircraft manufacturing industry to maintain its former status unless the jet fighter is ordered from CAC. Without that, CAC will pass out of existence; de Havilland will remain, developing other interests and representations. The Government Aircraft Factory is tied to the Supply Department.

CAC has never liked going outside its own field. It made buses for some years and after the war it had a magnificent prefab house project which was killed by the building-trade unions in the late 1940s under the Labour Government. It is not friendly to light aircraft although four small firms are going into small-scale production here with such machines. I remember Sir Lawrence Wackett telling me many years ago he hated light aircraft, for the amateur pilot sooner or later "had to kill himself."

CAC, which is a non-profit-making enterprise backed by Australia's industrial giants, may soon vanish. After all, it was formed 22 years ago to meet an urgent need. If that need has disappeared, then there is no reason for CAC.

STANLEY BROGDEN

Straight and Level

I OFTEN wonder whether the amount of time, effort and money that so many firms expend on house magazines is really worthwhile. I am sure, for example, that *Scruggs Heritage*, produced six times monthly by Boost High Gloss Images Ltd for Super Scruggsdyne Grouponics Ltd, is pure vanity—a glass in which the firm itself marvels at its own image.

I hasten to declare a *Flight* interest here—our readers' interest, too. I lack enthusiasm for these wasteful conceits (unless one possesses a Thinx BED-STEAD reading simulator one never has time to read them anyway) because they inevitably divert a firm's public relations effort away from attending to the needs of the press.

My views seem to be shared by Eric Mensforth, chairman of Westland, the world's largest helicopter manufacturer. He says:

"A quarterly magazine such as the projected *Westland Gazette* will be inadequate to the task of covering all our intentions for our new wide range of helicopters to the tempo of current events, and we have therefore decided not to proceed with it. Instead, whenever they are ready and appropriate, we shall send technical and general brochures, relying on the technical and general press to tell the day-to-day story of general achievement."

• Great-grandad's idea of a giant aircraft was Jules Verne's *Clipper of the Clouds*. (That's it on the left, tackling an ASR job.) Great-grandad really believed that when aerial ships arrived they would be able to take off vertically, hover at will, go swanning gently down the Grand Canyon or round the crater of Vesuvius, and, as we see, occasionally stop and rescue shipwrecked mariners.

Has the wonderful dream been shattered irrevocably? Not if we can believe the Bell Helicopter Corporation. They have sent me the picture on the right, showing a 300ft-long, 500,000lb, 200 m.p.h.-plus, atomic-powered VTOL transport. Bell believe that it could be built. And Bell have built more commercial helicopters than all the other US manufacturers combined.

• Blue Steel Mk 2, I read in a newspaper, "has two top-secret ramjet engines which boost it outside the earth's atmosphere, where it continues rather like a Sputnik for hundreds of miles until its pre-set electronic brains cause it to dive on to the target. In all those particulars it is identical with Skybolt."

• The voice of the great Brab, so often booming away about something ("any airline operator who uses petrol when he can use paraffin ought to be had up for manslaughter"; "supersonic airliners are a lot of nonsense," etc) was absent from the House of Lords throughout the passage of the Civil Aviation (Licensing) Bill. I was looking forward to some swinging Brabazonian swipes at the new legislation. No such luck.

• Announcing board changes following the selection of the British Aircraft Corporation team, English Electric list the merging firms as English Electric, Vickers and Bristol. In *their* announcement, Vickers list them as Vickers, English Electric and Bristol.

I am now eagerly awaiting a third permutation from Bristol. Perhaps the new BAC chairman, Lord Portal (who, according to *The Financial Times*, is to be "the impartial umpire") will decide the protocol of precedence.

• At last! The answer to the used-aircraft problem.

Papuan Air Transport, so I read in Trans-Australia Airlines' magazine *Trans-Air*, advertised in the local paper that they had no further use for an Avro Anson. They said it was airworthy, having flown the previous day, and they offered it free to the first person to remove it from Jackson's Airport.

It was snapped up by a club which intends to install it in a children's playground. What fun the Papuan piccaninnies will have, especially if the old Annie is still airworthy.

• And talking about Avro products, the firm will no doubt be interested to hear of a new type of Shackleton, a Jostler Shackleton, which appeared in a recent Air Ministry handout.

Enquiries round *Flight's* office revealed no knowledge of this aircraft. But an inquiry at source provided enlightenment. What had been hand-written was "another Shackleton"; what came out was the interpretation of an imaginative typist.

A pity. Jostler has a medieval ring about it, smacking of the tilt-yard and tournament, and sorts well with four Griffons.

• "It must not be forgotten that the purpose of transport is to serve the community in the widest sense—that public interest transcends private interest, that public accountability has to be married to individual enterprise, and that 'full information' is the best guarantee of sound intentions."—Peter Masefield.

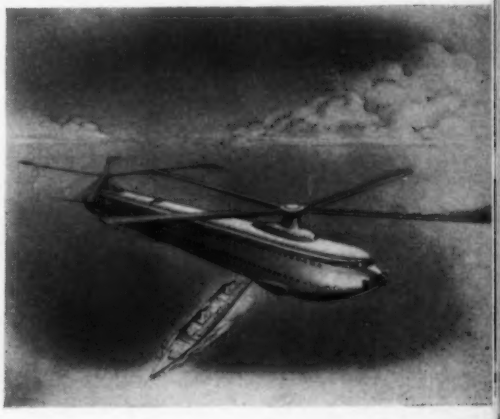
It seems to me that Masefield is not only eligible for the chairmanship of BOAC. He is also eligible for the chair of the new Air Transport Licensing Board. He can hardly be both—but in the opinion of many people it would be sad if he were neither.

• The Flight Safety Foundation recently had a meeting at which it was observed that the USAF no longer plans to use red light in the cockpit. Instead "dim" white light will be used, permitting—among other things—aeronautical mapmakers to use red as an additional colour. Most interesting.

The meeting went on to discuss maps in general, and in particular the pilots' old problem—akin to the classic one of the one-armed paperhanger—of how to spread maps out in a busy, crowded cockpit. I especially liked the remark, contributed by Capt Bob Buck of TWA: "We are like musicians trying to read a musical score with no place to put the music."

• "I have had enough of American jet planes. I am sick of them. You know all about the one that flew over our country—the US espionage plane. Then I come to Paris . . . and the noise of those American Air Force jet planes taking off and landing at Orly, they ruined my sleep."—Nikita Krushchev, quoted by *Aviation Week*.

ROGER BACON



Jules Verne rings a Bell (see second story)

Under construction at Eastleigh Airport, Southampton, by the Hampshire Aeroplane Club is the Hilborne Halcyon, a four-seater which is to be powered by two Walter Mikron engines. First flights of the new aircraft are expected to take place later this summer

Sport and Business

THIRTY AIRCRAFT and approximately 700 people attended the Northern School of Aviation Flying Club At Home on May 28 at Squires Gate. Aircraft from as far afield as Perth and Southampton were among the visitors, and the afternoon flying meeting was followed by a social evening in the clubhouse. The landing competition was won by A. McLennan (Scottish Aero Club) in a Gemini, and the bombing contest by J. Eccles of the host club. This was the first At Home to be organized by the club, and was so successful that an annual repetition is planned. Aircraft present included a Piper quartet (Cub, Comanche, TriPacer and Aztec) from Vigors Aviation, Bellanca 260 and Bonanza G.35 from Wayman Hales, McAlpine's Cessna 310, Lord Derby's Piaggio P.166 and Leyland Motors' recently acquired Dove.

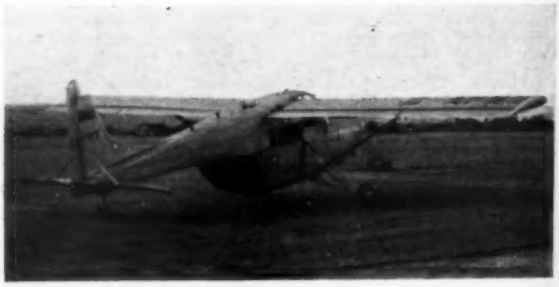
MEETING ON NEUTRAL GROUND at Sywell on May 29 were two competing teams of pupils from the Midland School of Flying at Derby and the London School of Flying at Elstree. All attempted a forced landing on to a mark on the airfield, a full-flap overshoot, a circuit and a landing, and each was checked through these manœuvres by the chief flying instructor from the other school. The two busy CFIs were Denys Stuart from Derby and John Schooling from Elstree. The contestants could fly Chipmunks or Austers as they pleased and the two individual winners from each team were checked by David Ogilvy, the Air Schools manager, for proficiency in the stall, steep turn and circuit-joining procedure. Winner overall was John Duer of Elstree and the runner-up, opposite number at Derby, was P. Granger.

Below, a Macchi MB.320 six-seater operated by Compling Brothers and Vanderval Ltd and based at Nairobi. The picture was taken at Kassse Airfield, which serves the Kilembe copper mines in Uganda

RETROSPECT

From "Flight" of June 11, 1910

An American Trick Flyer: With enthusiasm roused to its highest pitch by Glenn Curtiss' trip down the River Hudson, the people of New York flocked in their thousands to Mineola last week to see the exhibition flights of Curtiss and his pupils. On Saturday last about 15,000 people were present, and they were duly thrilled to the full by Hamilton, the most daring manipulator of the Curtiss machine. In his daring methods he much resembles the late Lefebvre, and several times when he suddenly swooped down from a height it seemed impossible that he would escape disaster, but in the next instant he had turned and was once more rising. Similarly, too, he circles round and round, gradually making the radius smaller and smaller, until the machine is at an alarming angle, but he never fails to right it, and with ease. All these tricks are greatly to the taste of his American audience, who prefer them to the lengthy flights of the ordinary kind.



Special rear-door windows and rearward-facing observers' seats are fitted in Prospector G-APWX, which is being delivered to the International Red Locust Control Service at Abercorn, Northern Rhodesia. The aircraft will be used for locating and destroying locust concentrations

AMONG NEXT MONTH'S CLUB EVENTS on the Continent is the Swiss Watch International Air Rally, to be held at Bienne during July 1-4. This rally takes place every three years in conjunction with the Bienne summer carnival, and this year's event is the fourth to be held. The occasion is organized by the Bienne Aviation Club with the collaboration of the Bienne tourist office and the support of the Swiss Aero Club. As an incentive to attendance, and as an incidental advertisement for the products of the Bienne area, a 17-jewel, shockproof, waterproof Swiss watch will be given to every pilot and passenger participating in the rally. The queue for further information forms at the Air Touring Department of the Royal Aero Club in Londonderry House, 19 Park Lane, London W1.

FIRST OVERSEAS BUSINESS TRIP by the Piper Comanche recently purchased by Lec Refrigeration Ltd was made on May 22. Piloted by George Farley and with sales director Frank Purley as passenger, the aircraft flew from Gatwick via Frankfurt to Vienna and Munich.

A NEW UNITED KINGDOM RECORD for glider speed over a 200km triangle was set up on May 31 by A. J. Stone, who flew a 127-mile course from Lasham with turning points at Devizes and Witney in a Skylark 3 in 3hr 7min, an average speed of 40.9 m.p.h. On the previous two days, as briefly recorded last week, Mr Stone had twice flown the 220 miles from Lasham to Bridgnorth and return, setting up a new out-and-return distance record. This flight was repeated because the pilot's camera, used to provide photographic evidence of his turning point, was found to have contained no film on the first day.

SELECTION OF PARACHUTISTS for the British team for the forthcoming world championships in Bulgaria will be made in two stages. An eliminating trial will be held at Thruxton this coming weekend (June 11-12), as briefly reported in last week's issue; and the resulting short list of eight or ten will go forward to a final trial at Woburn on July 16. The team will comprise four parachutists plus one reserve.

This smartly styled executive Dove, operated by Leyland Motors Ltd, was among the aircraft which visited Squires Gate for the Northern School of Aviation Flying Club At Home on May 28 (news-item above)

Two S.S. Zero airships over their base at Polegate, Sussex

RNAS AIRSHIP MEMORIES

INITIATIVE AND GALLANTRY IN ANTI SUB-MARINE OPERATIONS OF THE 1914-18 WAR

By M. J. GOLIGHTLY

TRYING to cross the coast at Brighton in a non-rigid airship after thirteen hours spent in flying from the Isle of Wight. . . . This is just one memory of serving with the Royal Naval Air Service in World War 1.

The home of airships in the Portsmouth Command was at Polegate, nestling under the Sussex Downs, near Eastbourne. Selected in 1914, the site was sufficiently advanced in 1915 to house and commission one airship of the S.S. type.

The small airship in those days would either fly or it would not fly; there were no half measures. Slung under its streamlined gas bag, or envelope, of 60,000 cu ft capacity was an ordinary B.E.2C biplane complete in all detail, but minus wings and tail unit. The elevator and rudder surfaces were attached to the envelope.

The engine was a 75 h.p. eight-cylinder air-cooled Renault. These units were a constant source of trouble through overheating, simply owing to an engine designed for aeroplane work being fitted to an airship whose maximum speed was approximately 35 knots.

Breakdowns over the sea were frequent. On one occasion S.S.13 had to be towed back to Newhaven by a destroyer, in heavy weather, after engine failure 30 miles south-west of Beachy Head. But in the course of time pilots and their air mechanics and wireless operators became expert at climbing out on to the under-carriage, locating and rectifying the engine fault and then restarting by swinging the propeller from behind whilst gripping a strut of the landing carriage with their knees, often at a height of 3,000ft.

Some notable achievements, however, were logged by these rather primitive craft. One record was a patrol from Dungeness to Land's End and back without landing. Another was an altitude record of 10,000ft.

The actual duties performed by the Royal Naval Airship Service were mostly defensive—escorting merchant shipping round our coasts and flying anti-submarine patrols.

In July 1916, parachute experiments were started at Polegate. S.S.13 was fitted to carry two parachutes of the Calthrop "Guardian Angel" type, attached to the underside of the chassis, and these were dropped from 200ft and 1,100ft respectively. Each carried a weight equivalent to that of a twelve-stone man. When they were released the airship was travelling at 40 m.p.h.; they opened after a drop of 100ft, descended at approximately 15ft/sec, and were in every way satisfactory. In August three more experiments were carried out, the first two with dummies and the third a live drop from 900ft by Sir Bryan Leighton. This was believed to be the first time that a man had successfully dropped from an airship by means of a parachute.

In 1917 the old type of S.S. airship became redundant and was replaced by a new type, the S.S. Zero. This had a gondola-shaped car slung underneath a hydrogen-filled envelope of the cigar-shaped non-rigid type, and carried a crew of three, pilot, engineer and wireless operator. The water-cooled Rolls-Royce engine had greater reliability and gave better speed (about 75 m.p.h. maximum). Armament comprised one Lewis gun and two 65lb bombs. These ships were more comfortable in every way for the crews but there was still little protection. Clad only in a leather flying coat, thigh boots and leather flying cap, the crew were exposed to the elements. There was no such thing as safety belts, and no parachutes were supplied. Nor was any provision made for sustenance of any kind, except that a few malted milk tablets were issued for an eight-hour patrol.

Crews met many hazards and adventures when patrolling in these Zero-type airships. On one occasion we went to meet and escort a convoy near the Isle of Wight. We had a following wind and arrived at the meeting point in 45min from the time of leaving Polegate. Shortly afterwards a gale blew up, and in trying to keep head to wind the pilot discovered that one of the rudder controls had broken. We left the convoy and began our struggle to return to base. After thirteen hours in the air we succeeded in crossing the coast at Brighton. We were evidently being watched by local people who did not realize our danger, for one resident telephoned our commanding officer to ask if his "blimps" or "silver queens" had nothing better to do than stunt over Brighton for the benefit of the public! Actually we were being so buffeted by the gale that we quite expected to crash on the high ground to the north of the town and be blown up by our own bombs.

Another incident occurred during a patrol on a clear summer afternoon. We received a wireless message to proceed to a plotted area off Newhaven where an enemy submarine, which had caused the loss of troopships sailing for France, was thought to be lying submerged. On arrival over the spot we could see her silhouette and promptly dropped our bombs. Although we were at about 500ft the explosion as the bombs struck home lifted us to over 1,000ft in what I should think was the quickest climb recorded for an airship.

By midsummer of 1917 Polegate was able to hold its own with any of the other eight airship stations dotted round Great Britain by completing 3,000 flying hours with only six Zeros. In 1918, 8,140 flying hours were achieved with a total of eleven ships. In fact during those two years the station did more hours of flying than any other Allied airship base; and it also instituted flying during the dark hours.

A record patrol of 50hr 55min was carried out over the English Channel by S.S. Z39 on August 11 to 13, 1918. On a previous patrol the air mechanic of this ship had carried out a remarkable repair to the steering controls at a height of 4,000ft. The engine was stopped, he climbed out of the car and, seating himself astride two very thin suspension wires, repaired the controls. The engine was then restarted, and the ship returned safely to base.

The wonderful flying year of 1917 was drawing to a close when it was marred by a fatality and chapter of accidents on the night of December 22. Five ships had left during the forenoon for patrol of the English Channel. The weather was sunny but hazy. Suddenly, at about 3 p.m. the perfect winter afternoon was obscured by a dense black fog which came down from the north-east with less than five minutes' warning. All ships were recalled to base, but although they could be heard above the dark pall which enveloped the station, not one of them could be seen. The pilots therefore decided, in accordance with previous orders, to head for the open country. S.S. Z6 landed safely in a field north of Hailsham; Z10 and Z9 put down near Jevington; Z7 and Z19 landed near the coast guard station at Beachy Head. By this time

(Left) hydrophone (anti - submarine listening) cable-drum on an S.S. airship; note also the bomb. (Right) Forward - mounted Lewis gun, manned by the wireless operator

RNAS AIRSHIP MEMORIES . . .

the ground was thick with snow. About 8 p.m. a fresh wind sprang up from the east, the fog lifted from the air station, and it was decided that in view of the possibility of the wind reaching gale force, and of the impossibility of holding the ships out in the open, they should fly back to base.

Z7 and Z19 were the first to leave. It was thought that the pilots must have mistaken for the Polegate base the Aldis lamps used to illuminate the ships on the ground at Jevington. The lifting mist, coupled with the snow and silvery moonlight, evidently deceived the pilot of S.S. Z7 (Lt R. Swallow, RN) for he attempted to land and struck Z10, ripping her envelope. It is thought that seeing his mistake he then opened his throttle and tried to climb quickly, but the flames from his exhaust ignited the escaping hydrogen from Z10, causing both ships to burst into flame. Z7 rose to about 400ft and then came down alight from end to end. The pilot was killed instantly, and the other two of the crew-members were found severely injured. With the utmost gallantry, the crew of Z10, finding it impossible to move the injured men, detached the now almost red-hot high-explosive bombs from the burning ship and carried them away to safety, knowing full well that they might explode at any moment. On the recommendation of the C-in-C Portsmouth, both were awarded the Albert Medal in Gold.

Meanwhile the senior flying officer, thinking that the crew of S.S. Z10 were still in the burning wreckage, dashed to the spot to rescue them. On reaching the car he found the crew had escaped, but before he could get clear of the ship both bombs exploded, blowing off his right arm. For his gallant action he was awarded the Albert Medal in Bronze.

The whole of the personnel of the station were shocked and stunned by these losses, but a magnificent example was set by the commanding officer, Wg Cdr Ivor Fraser, who decided to take one of the remaining ships left intact on the station for a fly round. This act appeared to break the spell of depression.

The year 1918 brought about many changes. The value of airships as a defensive weapon against enemy submarines was appreciated by higher authority and it was decided to intensify and extend the field of operations to the westward.

Two suitable sites where airships could be moored in the open, but protected from high winds by bays cut in the woods, were selected. One was at Slindon, near Arundel, the other at Upton at the head of Poole harbour. Each of these satellite stations proved their worth. They held the patrolling record for the mooring-out airship stations of the United Kingdom.

It was during the early part of this year that experiments were carried out in listening for submarines. Members of the wireless staff had a short course at Newhaven to acquaint themselves (from gramophone records) with the noises created under water by submarines and different types of ships' propellers. During night patrols at about 100ft up, cable was lowered into the water at the end of which was a hydrophone, a torpedo-shaped case containing a microphone, while at the receiving end the wireless operator listened on a pair of headphones. Although this brought no results in finding submarines, knowledge of the device evidently scared them off to safer areas; they could no doubt hear our engine overhead and this prevented them coming to the surface to charge their batteries. The hydrophone did, however, enable us to pick up convoys in the dark.

On April 1, 1918, drastic changes in the organization and personnel came about. The Royal Air Force was formed, and although airships and everything connected with them still came under Admiralty, officers and men became members of the new Service.

The month of May 1918 was a record one. With the co-operation of the sub-stations at Slindon and Upton over 1,000 hours of day and night continuous patrolling were achieved, and from May to November over 1,000 hours of night patrolling alone were carried out. Submarine activity had been acute up to this time, but it was a recognized fact that our increased activity played no mean part in keeping the English Channel clear of the underwater enemy.

JET FUEL AND SAFETY (Continued from page 788)

I am well aware that gasoline-fuelled aircraft have crashed and not caught fire, or else have burned only slowly, and for this reason it is unwise to speculate on what might have happened in any one of the above cases had the fuel been JP.4. The list must rather be considered as a whole, in which case it will be seen that in these accidents, which involved several of great severity, large quantities of kerosine were spilled, sometimes with fire, sometimes without; but that many people managed to escape. This must be more than a series of coincidences.

An operator's reluctance to use kerosine instead of JP.4 can only be justified on the grounds of severe economic handicap, and this brings us to consider briefly two important factors, fuel cost and availability.

Obviously, if the oil companies cannot produce kerosine in the necessary quantities at a price the airlines can afford, then we shall ultimately have to forgo its benefits. Some years ago the oil industry was saying it would be able to supply whichever fuel the airlines wanted, and that the two fuels were unlikely to command materially different prices. What have the oil companies to say about JP.4 prices today? It seems that IATA airlines—regardless of safety aspects—are proposing the widespread adoption of wide-cut fuel on grounds of economy. If they really want to reduce their fuel bill they should encourage the industry to design for economy, and show greater willingness to buy the less thirsty aircraft already available.

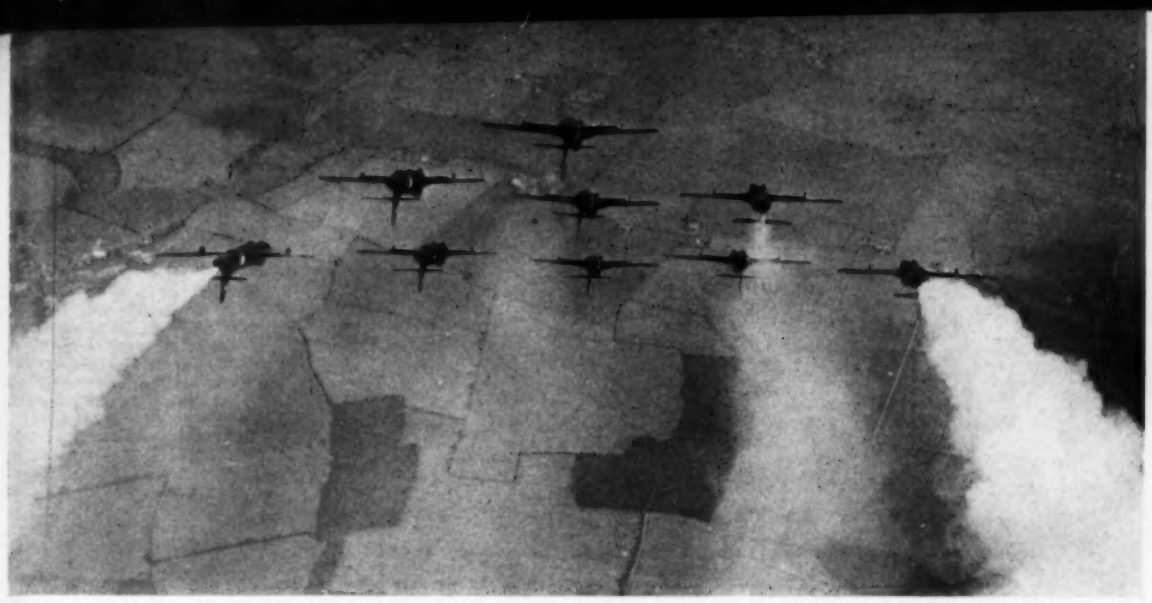
Sooner or later there is going to be another accident to add to the list; perhaps tomorrow, perhaps in a year's time. It may be a take-off or landing accident to one of the big jets. As the aircraft comes to rest, the deformed structure may disgorge thousands of gallons of fuel. If it is JP.4 the passengers' chances could be small, for the area can be ablaze within seconds.

To go flying entails the acceptance of risk. The business of those of us concerned with airworthiness is to identify and reject the greater risk in favour of the lesser, and such identification can be most difficult. But over this question of fuels and safety the right answer could hardly be more obvious.

ARMY AIR CORPS "AT HOME"

AN Open Day is being held by the Army Air Corps on Saturday, July 23, at the Army Air Corps Centre, Middle Wallop, near Stockbridge, Hants. It includes a flying display (from 2.30 p.m. to 4.30 p.m.) which will be centred around Chipmunks, Austers and Skeeters. There will also be a parachute drop by No 22 SAS.

A number of civilian firms are displaying equipment at Middle Wallop as part of the Open Day, which begins at 12 noon (when the camp is opened to the public) with static and side shows, which continue until 5.30 p.m. Bands of the First and Third Battalions, the Parachute Regiment, will be in attendance throughout the day and refreshments will be available.



"There be nine worthy and the best . . ." as Malory said in "Le Morte D'Arthur": Hunters of Treble-One Sqn, again the RAF premier aerobatic team, in characteristic attitude during practice for this season's displays

SERVICE AVIATION

Air Force, Naval and Army Flying News

Royal Commandant-in-Chief

AN announcement in the *London Gazette* last week stated that the Queen "had been graciously pleased to assume the appointment of Commandant-in-Chief of the Royal Air Force College, Cranwell."

Saluting The Queen

SIXTEEN Hunters from four Fighter Command squadrons are to fly past Buckingham Palace at 1300hr tomorrow (Saturday, June 11) in salute to the Queen on her official birthday, and Her Majesty will take the salute from the palace balcony. The Hunters, in four boxes of four aircraft each, are to fly at about 1,000ft at 400 m.p.h.; they rendezvous at Duxford and their inbound route lies over Halstead, Chelmsford, Victoria Park and along the Mall. On the return journey the Hunters are to cross Kensington, Harrow-on-the-Hill, Watford and St Albans. The fly-past is being led by Wg Cdr G. J. Storey, OC Flying at Duxford, and the squadrons represented are Nos 65, 56, 19 and 66.

Far East Command

A NEW Commander-in-Chief, Far East Air Force, has been appointed: AVM A. D. Selway is to take over this post from June 30, with the acting rank of air marshal. He succeeds Air Chief Marshal the Earl of Bandon, who has commanded FEAF since July 1957 and whose new posting is being announced later. AVM Selway's present Coastal Command appointment, as AOC No 18 Group and Senior RAF Officer Scotland, is being taken over by Air Cdre R. B. Thomson. The latter, now AOC Gibraltar, will have the acting rank of air vice-marshal when he takes up his new duties on June 24.

AVM Selway has been AOC No 18 Group since September 1958, and his previous posts in the 1950s have included command of the RAF staff at the British Joint Services Mission in Washington, Air Attaché in Paris and Commandant of the CFS. He won the DFC in 1940 and in the 1930s was a member of the CFS inverted flying team. Air Cdre Thomson became AOC Gibraltar in May 1958, having previously been Gp Capt i/c Operations at Coastal Command headquarters. He won both the DSO and DFC on anti-U-boat operations during the war, on the latter occasion having to spend three days in a dinghy when his Fortress was damaged by gunfire and had to be ditched.

Forty Years On

SOME 75 ex-apprentices, who joined the RAF forty years ago, are visiting Halton today to take a look at what life is like for their modern counterparts. The occasion is a reunion of the 1st and 2nd entries—February and September 1920—at No 2 School of Technical Training (Boys) at Cranwell; it is being held at Halton by permission of the Commandant, No 1 School of Technical Training, Air Cdre T. N. Coslett. The reunion—which was sparked off by an article, *Cranwell's Earliest Days*, by J. C. Corlett in *Flight* for February 5—includes a tour of the apprentices' school, films and slides, and dinner in Halton House.

Snake's Eye View

SEA VENOMS from HMS *Centaur* attacking an airfield, and RN Whirlwinds landing Royal Marine Commandos, appear in Eastmancolor in the Central Office of Information's first production in Cinemascope—a film about the Royal Marines called *Code Name Snake's Eye*. It is having its West End première at the Carlton, Haymarket, prior to being generally released by 20th Century-Fox.

Despite its rather formidable and mouth-filling title (Snake's Eye is the code-name for a town used as objective in a marine commando exercise), this film provides a crisp 27½ minutes' entertainment and should help to populate the RM recruiting offices. The flying sequences are well managed, particularly the catapult launches; though RAF spectators may squirm to see RN aircraft shooting-up some of their Meteors. Spoiling the planes for a ha'porth of paint, in fact.

IN BRIEF

The Queen's Colour for the Royal Air Force in the United Kingdom will be paraded at RAF Oakington tomorrow (Saturday) to mark the Queen's official birthday.

Parachute training in the Far East is being undertaken by men of 16 Independent Parachute Brigade Group, Aldershot, 100 of whom left the UK by Britannia on June 2. They are due to return on June 25.

In Buenos Aires and Singapore: supplies being loaded into a Britannia of No 99 Sqn for Chilean earthquake relief; and at left, Sqn Ldr John Garstin, captain of the record-breaking long-distance Valiant, being interviewed at the end of his flight from Marham

First air-to-air photograph of one of Olympic Airways' Comet 4Bs, 13 of which are to be operated by the BEA-Olympic consortium. Olympic have so far received two out of four on order

AIR COMMERCE

ANSETT'S TAKEOVER BIDS

SO far R. M. Ansett has failed in his two most recent bids to take-over local operators in New South Wales and New Guinea. In NSW, the board of East-West Airlines rejected an offer of no fewer than eight Ansett Transport Industries 5s shares for each £1 share. (ATI is the holding company for the various Ansett companies, of which Ansett-ANA is one. ATI 5s shares are quoted at roughly 8s.)

In the past two years Mr Ansett has taken over three intra-State operators—Butler Air Transport (NSW), which he has renamed Airlines of NSW; Queensland Air Lines; and Guinea Airways (now Airlines of South Australia). He objects to East-West because he says its operations bite into those of his NSW company.

East-West is a small operator of four DC-3s but is flourishing under the present management. It has a Friendship under charter from TAA. Some 90,000 passengers a year are lifted on routes inside NSW, covering towns such as Tamworth, Glen Innes, Warwick. Should Mr Ansett secure control of East-West, he will then own all the regular scheduled airline operators except TAA and Mac.Robertson-Miller Airlines.

The Department of Civil Aviation is known to be antagonistic to the Ansett attempts to secure control of the whole non-TAA system, for it is DCA policy that each State should if possible have one independent intra-State operator. By the terms of the enabling Act, TAA is forbidden to operate intra-State services.

It is now apparent that Mr Ansett desires to control all the non-TAA operators, which gives him intra-State rights, while TAA is forbidden to enter this field. There is no question of Ansett-ANA taking over Mac.Robertson-Miller as yet. Such a move would create a political uproar. The West Australian people are sensitive to moves by the East to take them over, and in any event DCA would do everything possible to stop this move.

The New Guinea take-over bid is another matter. Under the terms of the Government agreement by which Qantas leaves New Guinea in July, TAA takes over all Qantas services in the area and both Ansett-ANA and TAA are allowed to operate from Sydney to Moresby.

This means that while TAA can carry passengers from Sydney through Moresby to Lae and Rabaul without change of aircraft or airline (as the case may be) Ansett-ANA's passengers must get off at Moresby. If they want to go farther they must get into another operator's aircraft. This will obviously be to TAA's advantage on the Sydney - Moresby route.

The Government has made it plain that it would have no objection to a take-over by Ansett-ANA of either or both of the internal private-enterprise operators who have been competing with Qantas. Mandated Airlines (a subsidiary of the wealthy Islands trading firm of W. R. Carpenter) has 8 DC-3s and lifts about 23,000 passengers and 1,500 tons of freight a year. The other operator, Papuan Air Transport, lifts about 11,000 passengers a year with a Piaggio P.166 and a DC3, and smaller aircraft.

Mr Ansett has been negotiating with Mandated directors for some weeks, but the New Guinea firm has set a price of £500,000. The deal breaks down over the New Guinea demands for the maximum number of Ansett Transport Industry shares. Mandated shares are worth four times as much as ATI. Under the deal Mandated (Carpenter's) would secure up to 2,000,000 shares in ATI, the biggest single block of shares in that firm. Mr Ansett could not countenance this.

Mandated are very conscious of their strong position in bargaining. They have plenty of capital to buy one or more Friendships to compete with TAA's Friendship on the internal New Guinea services and they make a substantial annual profit. Unless Mr Ansett can get into New Guinea local services, however, his Sydney - Moresby services are bound to suffer in comparison to those of TAA.

For this reason, Ansett-ANA executives are seriously considering running an Electra on the route, instead of the planned DC-6B. This would seriously affect Ansett-ANA for neither they nor TAA can get enough hours with their DC-6Bs (two each) to make them pay in Australia. If Ansett-ANA runs an Electra, TAA will operate either an Electra or a "Super Viscount."

Seeing for himself at Avro on May 27 was (centre) the Minister of Aviation, Mr Duncan Sandys, here inspecting the fuselage of the almost complete Avro 748. With him (right) is Roy Ewans, Avro director and chief designer of the newest product of the Hawker Siddeley Group

AIR COMMERCE . . .

NEW RULES FOR FLYING EXAMS

THE Ministry of Aviation's recent decision to use only aircraft that are licensed in the public transport category on the Civil Aviation Flying Unit (the body which tests pilots for instrument ratings and commercial licences) raises some problems. For one thing it rules out the use of any single-engined aeroplane at night since this is prohibited by the weight and performance regulations. It also implies that pilots with commercial licences on single-engined types are restricted to flying only by day. These limited licences, say the MoA, cannot then be simply endorsed for multi-engined types nor can the holder take a test for an instrument rating.

The new rule about night flying (which comes into effect on July 1) means that candidates for commercial licences can now only take their night flying tests on a Dove, the twin standardized by the CAFU. But since the Chipmunk is the most widely used trainer for instrument ratings and commercial licences in the UK (and is used by the CAFU for the day-flying tests) a candidate for a commercial licence may find himself taking a night test on a totally unfamiliar type, a situation already familiar with the instrument-rating test. At night the candidate will be expected to demonstrate a take-off and landing and overshoot procedure, with the proviso that "the candidate will not be required to deal with asymmetric conditions." Only by accepting the restrictions recorded above can the "twins at night" rule be circumvented.

Other changes in the CPL and instrument rating tests include a complete revision of the day-flying procedure. For the CPL test, basic and cross-country tests have been combined into one flight and a demonstration of spinning is no longer required. This may be the result of caution about the particular spinning qualities of the Chipmunk or the belief that once spinning has been taught—and endorsed in a logbook as being properly understood—this knowledge requires no further testing.

The instrument rating and renewal tests have been revised to bring them into line with "modern operational practice." Tests will be carried out over four alternative airways routings: Stansted to Birmingham; Birmingham to Stansted; Stansted to Gatwick and Gatwick to Stansted. The revisions are set out in detail in Civil Information Circulars 48 and 49/1960, issued on May 25.

BOAC v. EAGLE FREIGHT APPLICATIONS

BOTH BOAC and Eagle have filed applications with the ATAC to operate transatlantic all-freight services. The competitive applications, which may be seen in the public announcements column elsewhere in this issue, are similar, calling for an initial frequency of two return flights weekly increasing to daily flights later, and to be inaugurated on September 1 this year.

The terminals in the UK are London, Manchester and Glasgow, and those in North America New York, Boston, Detroit, Chicago, Philadelphia, Washington, Baltimore, Montreal and Toronto. The aircraft specified are DC-6As in the case of Eagle and, in the case of BOAC, 707s, Britannias, DC-7Cs, Constellations and VC10s—and, surprisingly (since BOAC do not own the type), DC-6As.

It will be recalled that in the spring of 1959, BOAC filed an application with the ATAC for transatlantic freight services. This was withdrawn, because Airwork are the holders of the licence, though their DC-6A service in 1955 was short-lived for economic reasons and has never since been implemented. The question now is whether Airwork will oppose the BOAC and Eagle applications; it is understood that they will not do so.

The BOAC application recalls the corporation's evidence last year before a Parliamentary select committee:—

"When the corporation has its fleet of Boeing 707 aircraft in full operation across the North Atlantic in 1961 it expects to have 2½-3 times the volume of freight capacity which it now has. . . . The corporation will keep under constant review the freight requirements of the North Atlantic route should all freight support be required there at some future date."

NOISE AND PUBLIC ACCOUNTABILITY

SO far, the one person to whom the public can turn for relief from jet noise—the Minister of Aviation—has, in their opinion, sadly failed them. By declining to publish the results of noise tests (the validity of which must thus be in doubt), by declining to publish prescribed noise-abatement rules, and by sidetracking MPs with misleading acoustical data, Mr Sandys has acted in a manner which could well, by comparison with the way the problem is being handled in America, be described as maladroit.

An exceedingly difficult problem is being aggravated by secrecy and evasion. No public relations expert or psychologist needs to be consulted for it to be realized that airport residents who feel they are being deceived will put up with much less noise than those who feel that their interests are being cared for. Arthur Skeffington (Lab, Hayes and Harlington), in last Friday's Commons debate on jet noise, asked the Ministry to be "less secretive" and referred to "a grave failure in public relations" between London Airport and the local residents and, to some extent, between the Ministry and the public. The Parliamentary Secretary, Mr Rippon, was subjected to keen questioning. During the debate Mr Rippon revealed that perceived noise decibels (PNdb) are, from June 1, to be adopted for the relative assessment of annoyance instead of db, the misleading nature of which has frequently been referred to in these columns and elsewhere. (His subsequent statement that the noy, N, is the same measurement as PNdb, was challenged by Mr Skeffington.)

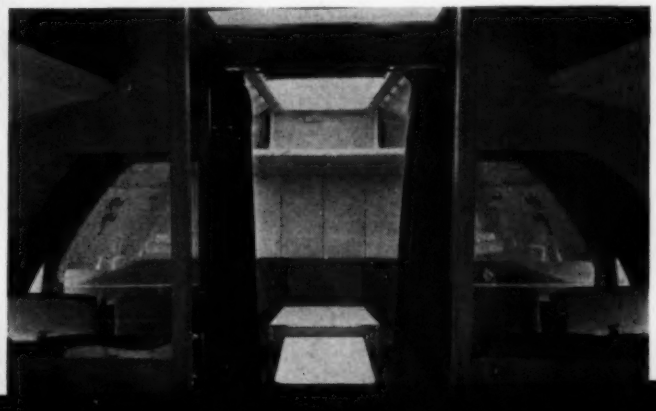
The US attitude, recently defined by the Federal Aviation Agency, is that "such operational problems as are created will be compensated for by the increased benefits obtained in the public interest to be derived from the reduction of aircraft noise." The FAA said this in proposing, as it did last month, special noise-abatement rules for New York International (following the proposal of similar rules for Washington and Los Angeles). These rules have been published in full, and public comment and the views of interested parties is invited by June 27.

The Port Authority considers that its own procedures have been designed "to give our airport neighbours the maximum relief from excessive aircraft noise, which we believe they have a right to expect. They will, therefore, remain in effect and we expect the airlines to observe them faithfully." Asked whether the PNYA would continue to rebuke, in public, airlines which break the rules, a PNYA spokesman told *Flight* in New York recently: "We still monitor every take-off and each non-compliance is reported to the airline. But we don't like calling people names in public."

That the problem itself is being thrashed out in public in the US is particularly worth noting. And not only are US noise-abatement rules discussed in public: a vast scientific literature now exists, a large part of it the work of the PNYA's acoustical consultants, Bolt Beranek and Newman, all of which is public information. It is ironic that London Airport residents are finding more relief from their jet-noise grievances from information supplied by the New York authorities [Hansard, June 3, col. 1851] than from information supplied by the Ministry.

Footnote: Last week Mr Sandys, at a private two-hour meeting in London, urged all those concerned with air transport to give more attention in future planning to the limitation of noise.

Those present were: Geoffrey Rippon, Parliamentary Secretary to the Ministry of Aviation; E. A. Armstrong, Controller of Aviation Ground Services at the Ministry; M. J. Lighthill, director of the Royal Aircraft Establishment, Farnborough; H. Constant, director of the National Gas Turbine Establishment; R. S. F. Edwards, general manager, London Airports; J. D. Pearson, managing director, Rolls-Royce aero-engine division; Sir Arnold Hall (Bristol Siddeley Engines); Sir Aubrey Burke (Hawker Siddeley group); Sir George Edwards (British Aircraft Corporation); E. C. Wheeldon (Westland); E. C. Bowyer, director of the SBAC; Sir Gerard d'Erlanger, chairman of BOAC; Basil Smallpeice, managing director of BOAC; Lord Douglas, chairman of BEA; C. J. Stevens (BIATA); and W. H. Lyons (Pan American), representing the Foreign Airlines Association.



Recently converted by Transair to 61-seat high-density configuration are two ex-Airwork 40/48-seat Viscount 736s. The main cabin seats 57 and a rear lounge with seats for four occupies the space originally taken by the rear baggage compartment. The aircraft are chartered to BEA for their German network

AIR COMMERCE . . .

TWO GROUP CHARTERS A DAY

SHOULD BOAC be unable to sell all their DC-7Cs it is unlikely that these aircraft will stand around idle at London Airport. During the past few years non-scheduled group charter travel across the North Atlantic has really been booming, and the DC-7Cs have a heavy commitment to carry "common-interest parties" back and forth across the Atlantic. Examples of such groups—all carefully defined by IATA—are the Country Club of Coral Gables, Miami, or the Royal Ballet. This kind of charter now represents very big business, and BOAC have more than two such charters a day already booked throughout the present season. It is, in effect, a fourth class on the Atlantic, with very low rates being made possible by guaranteed high load-factors. It is rather an exclusive market, not open to every non-scheduled carrier who might like to have a go. Every flight requires CAB approval, and the US Board regards this market as the preserve of the North Atlantic scheduled carriers, all of whom have filed an IATA charter tariff with the CAB.

RADAR HAS ITS HAZARDS

BETWEEN the wars British daily newspapers carried stories of an inventor who had designed a "death ray" which he claimed was effective at short distances. Unlikely as the idea seemed at the time, a number of recent warnings about emission dangers from radar scanners suggest that this pre-war inventor might merely have been a few years ahead of his time.

A Canadian Department of Transport information circular contains a warning that when an airborne radar set is operating on the ground, an area extending 35ft from the front must be regarded as a fire and explosion hazard zone. No volatile liquids must be stored or handled in this locality, and an area 46ft from the dish must be considered a zone in which there is a danger to health.

There is a warning also that ground staff should avoid exposure to the primary radar beam when the dish is not scanning, and that they should refrain from examining dishes, waveguide openings or feed horn when the set is transmitting. Flight crews are not exposed to transmissions from their own sets, owing to the insulation provided by their aircraft.

BEFORE TRANSPORTING THE CUSTOMERS

LOOKING back on the now completed first phase of BOAC's Boeing 707 crew-training programme, Brian Wygle, one of the Boeing pilots who has been assigned to BOAC, tells *Flight* that it was "one of the easiest conversions we have done."

That the BOAC conversion, in Boeing's view, was one of the easiest is not altogether remarkable: after all, no other new 707 customer could claim 60,000hr of previous scheduled jet experience. But the corporation's approach to the 707 was far from blasé. The training programme, a part of which we witnessed on a recent proving flight, may have been one of the easiest; it was also one of the most thorough. Since comparisons are odious, let it simply be summarized as follows:—

(1) BOAC's 707 crews, all with previous Atlantic route experience, carried out no fewer than 11 transatlantic round-trip proving flights (each pilot had two) before, on May 27, fare-paying passengers were carried.

(2) The previous conversion programme at Tucson, Arizona, involved about 360hr with two aircraft flying, between dawn until after dark, daily three 4½hr details each—27 flight training hours per day. (This intensity was sustained for almost two weeks, another week being at half the rate with one aircraft.) In attendance were six Boeing instructor pilots and six Boeing instructor flight engineers.

(3) This conversion programme is being continued at RAF St Mawgan, Cornwall. About 150 pilots and 80 E/Os are being trained on courses lasting until next spring; there will be 30-40 daily take-offs and landings on each normal flying day.

(4) Each 707 pilot had 35-40hr on the Link flight simulator (the first simulator ever delivered to BOAC in advance of a new aircraft). According to the 707 flight manager, Capt Tom Stoney, this equipment was "an absolute godsend." It is also said that Boeing were very impressed with the standards of BOAC's 707 crews on their arrival at Seattle for actual flight instruction.

(5) Each pilot attended a six-week ground technical course followed-up by the routine ARB-type examination.

The above lists the syllabus in reverse order; it boils down to the fact that each BOAC pilot has 35-40hr on the simulator; 15-20hr flight conversion (which Capt Stoney says is actually worth double due to over-the-shoulder observation of colleagues); and about 30hr on the route. In other words, a BOAC pilot spends no less than 100-110hr in the 707 cockpit (or cockpit simulator) before transporting the customers.

BOAC are training 85-90 707 crews, i.e., nearly six per aircraft in the 15-strong fleet. A crew comprises first pilot, second pilot, flight engineer and navigator. The prickly question of whether or not there shall be a third pilot has, for the time being, been resolved by the inclusion in the crew-complement of a co-pilot under training who, in between the simulator and the flight-conversion phases, accompanies the aircraft on the route.

The old 707 dutch roll bogy is, incidentally, a bogy no more. The ARB's pilot, D. P. Davies, did not like the 707's original asymmetric-power V_{mc} and dutch roll behaviour; but with the bigger fin and full-travel rudder-boost the 707, Capt Stoney says, is "extremely difficult to dutch roll even with the automatic yaw damper cut out." The training programme calls for this to be demonstrated. Landings in crosswinds of up to 37kt have also, he says, been demonstrated during training.

PENALTIES OF ELECTRA LIMITATIONS

OPERATING restrictions on the Lockheed Electra are affecting quite adversely the economics of both Ansett-ANA and TAA. The drop in Electra passengers since the restrictions were imposed is estimated to have been more than 5 per cent, and the extra hours that have to be flown on Electra services have been involving the two airlines up to £10,000 a week each in direct costs. Many Melbourne - Sydney passengers are said to be flying via Canberra in Viscounts and Friendships, rather than direct by Electra.

The effect of this on the economics of the two Australian operators worsens an already difficult battle against rising costs. Wage and other increases this year will cost both Ansett-ANA and TAA £A300,000 a year, Senator Paltridge, Civil Aviation Minister, has told the House of Representatives. He was being questioned by members on the recent fare increases, which are roughly 7½ per cent first-class and 10 per cent tourist class. The round of increases was the ninth in ten years, "but Australian air fares are still among the world's lowest, if not the lowest," the Minister said. Freight rates have not been altered.

MR WORLDWIDE REPORTS

MOST annual reports have a distinctly national character. Those from America tend to be flamboyantly self-analytical. French reports are often more artistic than useful. Those hailing from Britain are prone to be faintly bureaucratic. Many African and Asian reports are magnificently confused and disorderly. The annual report of Swissair, however, is in none of these categories. Nobody glancing through it would link it with the land of alpenstocks and eidelweiss. Indeed, its character is supranational, rather as if it had been composed by Swissair's legendary salesman, Mr World-Wide. The English—or rather the Anglo-American—version of the original (in both French and German) is somewhat abridged. Perhaps in this context, refined would be a better term than abridged, for the boiling-down process has left the report clear of the chairmanic pontifications which are

This is not just another 707, but the first Boeing 720 for Western and the first to be depicted in the air. Three are on order and the first deliveries will be made next April

such a wearisome feature of modern airline industry reporting.

In terse, accurate prose the reader is told precisely how the airline made a profit last year; how it is tackling the transition to jets; why co-operation with SAS—and with BEA and Air France—is advantageous; what is the basis of the airline's tariff policy; and so on. This text is supplemented by useful graphs and block diagrams.

The four essential economic facts last year, neatly summarized in the report, are these: revenue rose by 10 per cent to Swiss Francs 278 million (£23m) while costs were up by 9 per cent to SwFr260m (£21m); capacity expanded by 7 per cent to 197 million tonne-kilometres (135 million c.t.m.) whereas traffic increased by 8 per cent to 120 million tonne-kilometres (82 million c.t.m.). From these figures it can be seen that unit costs rose slightly to 1.32 per a.t.k. (38 pence per c.t.m.), this being almost entirely due to a 14 per cent increase in labour costs, which now account for one-third of total expenditure. This extra burden exceeded the savings on fuel (lower prices) and on standing charges (higher utilization).

The utilization figures are so good as to call for separate comment. Last year the DC-7s averaged 11.1hr daily and the DC-6Bs 9.1hr, these two types each accounting for about one-third of the total output.

The rise in costs were accompanied by a slight fall in average revenue rates. Fortunately for Swissair, these adverse developments were more than offset by (a) a rise in load factor from 60 to 61 per cent, and (b) a very sharp increase in revenue earned from various non-flying activities.

The consequence of this careful husbandry was an exceptionally profitable year. Out of the Fr18m profit, an additional Fr10m was ploughed back as additional depreciation, a further Fr2m was put back into reserve, leaving Fróm as a 6 per cent dividend for the airline's 10,600 shareholders. Perhaps the significant feature of this profit record is that it was not accompanied by the long-haul expansion which has been primarily responsible for Swissair's improving financial position in preceding years. Last year saw the regional disposition of the company's business more or less unchanged, with Europe accounting for 39 per cent of revenue, the North Atlantic for 31 per cent and the Middle and Far East for 12 and 11 per cent respectively. The remaining 7 per cent is accounted for by the South Atlantic routes.

A surprising omission from the report is that nothing is said about prospects for 1960. From what can be deduced, however, it seems that it may be more difficult for Swissair to declare a dividend this year.

AIR CHARTER'S THIRD LINK

IN recent weeks Air Charter's Channel Air Bridge division have announced ideas for co-operation both with the railways (rail/air to Calais) and with the boats (no-passport trips out by air and home by sea). Also just concluded is further agreement for more co-operation in the air. Recently approved by the ATAC are five joint applications from Air Charter and East Anglian flying services to operate inclusive tours. All cover the route from Southend to Ostend and are effective during the period from the end of last month until mid-September.

These jointly operated ITs continue a previous association between these two Southend-based operators, and this year are proving very popular—it is estimated that during the season 55,000 people will be carried on this one service alone. The division of carriage is about 4 : 1 in favour of Air Charter, who operate an all-passenger Bristol 170 and a 75-seat DC-4 on this route. East Anglian (one of the airlines in the proposed independent six-pool) operate a Viking.

COMPETITION FOR THE BRITANNIC

IT is expected that the US Military Air Transport Service will soon make its choice of the strategic freighter aircraft it has long been seeking. Hitherto the choice has been among cargo versions of the KC-135, the DC-8, Boeing 707, Lockheed GL-207, and the Canadair CL-44.

Only one of these aircraft, the GL-207 (which is a development of the Hercules fitted with Rolls-Royce Tynes instead of the originally projected Allison T61s) has truck-bed height rear-loading capability. This is stated to be a MATS requirement—though the other types, all swing-tailers, are all still said to be in the running for a MATS order which, an American source reports, will be "shortly after July 1."

Now Lockheed have come forward with a completely new design, a compromise between the high speed appeal of the jet contenders and the easy loading (and air dropping, another MATS requirement) capability of the GL-207. It is the GL-207-42, which appears to be a GL-207 fuselage with a new swept wing and tail assembly, and four turbofan jet engines (Pratt & Whitney JT3D-11s, each of 22,000lb thrust). Maximum payload would be 77,000lb, cruising speed 440-490kt, and payload-range capability 41,000lb for 4,000 n.m. or 20,000lb for 5,500 n.m. Take-off to 50ft would be 3,800ft to 4,000ft.

On the right is Capt Zwi Tohar, chief pilot of El Al, and an ex-RAF Bomber Command pilot (Wellingtons). He is reported to have been the commander of the Britannia that flew Adolf Eichmann from Buenos Aires to Israel last month. In this "Flight" picture, taken two-and-a-half years ago in Tel Aviv, he is seen with his managing director, Brig-Gen E. Ben-Arzi

This interesting new compromise cargo jet is a project only, but it could be delivered, say Lockheed, 32 months after the order to go ahead. If (and it remains a big if) an order is given before the end of this year, deliveries could begin before the end of 1963. MATS are said to be calling for mid-1964 delivery for their new "work horse" strategic freighter. It thus appears that RAF Transport Command and the Military Air Transport Service of the USAF are working to the same sort of timescale in respect of a strategic freighter. No firm order has yet been placed for the Short Britannic, though work has been in hand for more than a year at Belfast and the RAF appears to be committed to the turboprop design. If—as seems probable—MATS decide on a jet freighter, some strong commercial export competition for the Britannic can be expected in 1964 and beyond.

RENT-A-JET

THE price of a new Lockheed JetStar is about £426,000, or £434,000 with a de luxe interior. Though sales of Lockheed's appealing little executive jet are not yet substantial, terms are being offered by the new Pan American subsidiary JETS (Jet Executive Transport Services Inc) which may well increase the market for this aircraft. The world's biggest international airline is thus now in the aircraft hire-purchase business as well as in the hotel industry.

JETS is offering JetStars for hire under six-year leases, with an option to purchase at the end of the lease. Assuming that the customer prefers the more expensive de luxe model, his down-payment would be about £21,700 (5 per cent of list price). A further £65,000 (15 per cent) would become due a year before delivery, and a further £34,800 (8 per cent) six months before delivery. The balance of about £312,500 would be payable in six equal yearly instalments plus interest on the unpaid balance. There are arrangements for purchase to be made at any time, with service charges being payable to JETS. The above sums, it should be noted, are rounded-off $ conversions.

The Pan American subsidiary has bought 16 JetStars from Lockheed with an option until September 30 to purchase all production aircraft built up to July 1, 1962. Under Lockheed's contract with JETS, Lockheed will not lease JetStars, and JETS is required to notify Lockheed before making outright sales.

—AND PANAM INVESTS IN AUSTRIA

ALSO worth watching are Pan American's activities in the international airline take-over-bid field. Unconfirmed reports from Brussels, *Flight* understands, suggest that the American carrier is considering an investment in Sabena, and hence in Air Union. Meanwhile, speculation about the financial future of Austrian Airlines appears to have been resolved by a report from New York that Pan American have signed a draft agreement with the Austrian operator whereby the US airline will provide commercial, technical and operational advice and personnel.

Austrian Airlines, founded in September 1957, began operations in April 1958 using Viscount 779s leased from Fred Olsen. Currently being delivered to the airline are six new Viscount 837s. Four have already been delivered; the remaining two will follow this month and next. Original shareholders in Austrian Airlines were Austrian public and private corporations nominated by the two political parties forming the Austrian Government, and (with one per cent each) SAS and Fred Olsen.

"DISAPPOINTING" FAIRCHILD F-27 SALES

SALES of the US-built F-27 Friendship have not come up to expectations. The president of Fairchild, the former Capital Airlines president James Carmichael, confesses that the sales programme "remains a disappointment and something of a problem."

Total sales to date account for about 80 aircraft, of which all but a handful have been delivered. Recently a four-day working

AIR COMMERCE . . .

week was introduced at the Hagerstown factory, and production rate is down to one aircraft per month. According to John Foley (Democrat representative for Maryland) Fairchild is "in a very tough way." He has been urging the Defense Appropriations Sub-Committee to reverse the USAF's decision not to buy the F-27: the F-27, he says, does two-and-a-half times the work of the C-47 at only 39 per cent of the ton-mile cost.

Meanwhile Fairchild are offering new versions of the F-27 for military application in the hope that the USAF will, in fact, reverse its decision. These projects are:—

M-258G This appears to be the military designation of the commercial F-27B Freightship, of the type delivered to Northern Consolidated. It has a heavier floor and enlarged forward door. *Powerplant:* Rolls-Royce Dart RDa.8.

M-258H This is the same as the above but with claimed STOL capability conferred by double-slotted flaps and variable-incidence tailplane. *Powerplant:* Rolls-Royce Dart RDa.8.

M-258J This is the "H" with STOL capability, but unpressurized and with rear loading. *Powerplant:* Rolls-Royce Dart RDa.8.

M-258K This is essentially the "J," but powered by GE T64-8 turboprops.

There is a glimmer of hope for a further substantial commercial order for the Fairchild Friendship: Eastern Air Lines were reported in April to be discussing a possible order for about 30 of the F-27E (RDa.10 project) version.

Footnote: Fokker now use the designations Series 100 and Series 200 to distinguish, respectively, the RDa.6 Dart and RDa.7 powered versions of the Friendship. According to Fairchild usage F-27 and F-27A connote the same difference.

MOSCOW CHANGES AIRPORTS

IN a surprise Notam from the USSR Aeronautical Information Service, it was announced that Sheremetievo is to replace Vnukovo as the Soviet capital's international airport as from June 1. This was the date on which the Notam was actually received by the Ministry of Aviation AIS, though the Russian statement was dated May 18. Vnukovo may be used as an alternate, but Kubinka, the existing alternate, is now closed.

Sheremetievo is located about 17 miles NNW of Moscow. There is one runway, 07/25, 11,480ft by 260ft (3,500m by 80m), equipped with ILS and full approach threshold and runway lighting. Approach to Sheremetievo shall be conducted at flight levels assigned by control, and deviations are "strongly prohibited."

The Russian authorities have supplied, in their customary way, full information describing the facilities and flight rules.

FAREWELL AIRCO

"SINCE the three member companies of Aircraft Manufacturing Co Ltd now find themselves members of separate groups," a DH statement explains, "they are discussing arrangements whereby the D.H.121 project will in due course be fully undertaken by the de Havilland Aircraft Co Ltd. Hunting Aircraft and Fairey Aviation have agreed to co-operate to the extent necessary to ensure the planned programme."

This ends speculation about the future of Airco, whose members now have divided loyalties in the reshaped industry. The company was formed in January 1958, with DH having a 67½ per cent share, Hunting 22½ per cent, and Fairey 10 per cent.

BREVITIES

Almost 50,000 flying hours had been completed by Douglas DC-8s by the second anniversary of the first flight on May 30.

PanAm's new £4 million, four-acre terminal building at Idlewild Airport was opened on June 2.

Derby Aviation have had approved by the ATAC a normal scheduled service between Cardiff/Bristol and Palma. It will operate between April and October each year until 1966.

A statement made in Basle last month by a director of Balair says that no indications of mechanical failure have been found which would account for the accident to the airline's DC-4 in the Sudan on May 15.

Last Friday was the day on which BOAC re-opened services to Amman, Jordan, after a break of nearly four years. The outbound service leaves London on Fridays, calling at Rome, and the return service leaves Amman on Sundays.

Air Ceylon's proposed service to Canton is threatened by Chinese refusal to disclose air navigation information about Chinese territory. The Chinese say that this is because they fear that the information could be used by Air Ceylon's operating partner KLM for military purposes.

BEA Comet 4B services to Oslo started on June 1 but because of noise objections Gardermoen Airport—25 miles from the city—and not Fornebu was used. Permission to use the latter airport may be given in 1962 when a new runway is completed.

It is reported that Boeing estimate that the 727 should fly in September 1962. The design has apparently been offered to Qantas, TAA, Ansett-ANA and TEA for delivery in 1963; previous quoted delivery date was mid-1964.

A new air transport company formed in Paraguay is Corporación, Paraguaya de Transportes Aereos SA. The principal shareholder is a US concern, the International Products Corporation. The airline is to operate a freight service between Asunción, Montevideo, Sao Paulo and Buenos Aires and internal services in Paraguay.

Jet Aircraft Flight Planning Data, Civil Air Publication 159, is now on sale through HMSO price 3s 6d. It contains flight-planning data sheets for typical jet aircraft with explanations and examples on their use. As from October 1 this year it will be required reading for flight planning examinations for the senior commercial pilots', airline transport pilots' and flight navigators' licences.

Schiphol's new runway 06/24 came into service on June 1. It is 10,660ft long, 150ft wide, and can withstand a single isolated wheel load of 160,000lb.

It is reported that the independent airline Air Condor, an associate of Shortcut Aviation Ltd, is likely to lease two Viscount 700s from next January. The company owns a Bristol Wayfarer, leases a Bristol Freighter, and is about to take delivery of a Viking.

Another operator to convert surplus piston-engined airliners to all-freight configuration is JAL. The Japanese carrier has asked Douglas to convert two of its four DC-7Cs to DC-7F standard, for operation between Tokyo and San Francisco at twice-weekly frequency from February 1961.

No-passport, 24- or 48-hour trips to Paris are available on the Skyways coach/air service which operates daily from Lympne Airport and at weekends from London. Day return flights are restricted to groups of not less than 15 passengers "because of operational limitations."

Aer Lingus inaugurated a direct service between London and Shannon on May 30. The return flight will connect with incoming transatlantic services on six days a week and the service from London will connect with flights from Shannon to New York and Boston. The 17-day mid-week excursion fare is £16 10s.

BOAC's Boeing 707 service to Montreal was inaugurated on June 1. Just before the aircraft landed at Montreal it was noticed that a windscreen had cracked and passengers were transferred. This is the second recent report of this particular fault (see "When Pressure Failure Threatens," *Flight*, April 15, 1960).

Jet noise was the object of a meeting of leading European airport officials in Paris recently. The following airports were represented: Amsterdam, Basle, Brussels, Copenhagen, Dublin, Geneva, Lisbon, London, Oslo, Paris, Rome, Stockholm and Zürich. The Association of German Commercial Airports was represented, and the Port of New York Authority attended. (See note on page 807.)

As we go to press it is announced that the CAB has refused a BOAC application to operate eight charter flights for British lawyers across the Atlantic this summer (see page 808). Reasons given are that:—(1) the participants would be drawn from associated bodies of the British legal profession whose combined membership exceeds 19,900 and may include family members; (2) passengers could choose from any of eight departures and eight return flights.

These air-starting apron vehicles are Atlas Copco Air Partners, seen here in use on a Sabena 707 at Ringway and a TCA DC-8 at London

THE INDUSTRY

Teddington Controls' US Collaboration

AN important association has been announced between Teddington Aircraft Controls Ltd and a US firm, Western Gear Corporation. The Precision Products Division of the latter company, whose headquarters are at Lynwood, California, has made a statement from which the following are extracts:—

"Our two companies are collaborating to provide considerably expanded design and manufacturing facilities in the controls field for customers in the United States. Western Gear's activity will utilize Teddington's design and products . . . incorporate these products in missile, rocket and aircraft systems, and assume complete sales, service and manufacturing responsibilities. Western Gear will also provide factory service for Teddington equipment currently in use in the aviation industry in the United States. Teddington controls are extensively applied on aircraft jet engines, including Rolls-Royce Conway powerplants on DC-8s and Boeing 707s.

"The equipment which Western Gear will make available as a result of this association with Teddington includes electromagnetic valves, hot-air and gas valves, time and pressure switches, pressure regulators and related control equipment.

"The Precision Products Division of Western Gear has previously specialized exclusively in aircraft, rocket and missile components systems, as well as ground handling and test equipment."

The new development, say Teddington, should be of great significance in the effect it will have on their export business, and should also be of interest to makers of British aircraft which operate in the United States and use Teddington equipment.

Firth Cleveland Acquire Habershon

THE Firth Cleveland group have announced the acquisition of the old-established firm of J. J. Habershon & Sons Ltd, of Rotherham, Yorks, manufacturers of hot rolled strip in mild, carbon, alloy and stainless steels. Well known in the aircraft industry, Habershon have held AID approval since 1926 and have exhibited at the SBAC Show for many years past. Firth Cleveland already have a number of steel interests, including Firth Cleveland Steel Strip Ltd and the Sheffield Wire Rope Co Ltd.

Stored-Air Starters

FROM I.V. Pressure Controllers Ltd comes a brochure containing detailed reports compiled by technical representatives of three organizations which have placed aircraft at the company's disposal for test demonstrations of the Jetstart Mk IV and Mk V stored-air starter trolley. The three organizations and their aircraft were A. V. Roe (Vulcan B.2); USAF, Wethersfield (F-100D); and Pan American Airways (Boeing 707). Also included is a report by a de Havilland representative who visited the IVPC factory at Isleworth, Middx, and investigated the equipment.

On two or three detail points the reports are critical, and the firm is to be congratulated on publishing them *in extenso*; it is apparent that where practicable the various suggestions made are being acted upon.

I.V. Pressure Controllers have experience in the design and development of stored-air-type starter units and air distribution panels dating back to early experiments in air-starting the Armstrong Siddeley Python engine when it was installed in the Lancaster flying test-bed. Their first production order was for the Royal Navy, and the trollies concerned have been used for several years in the Fleet Air Arm. Their trolley specifically designed for large jet engines is Mk IV, and this is designed to produce air at a minimum of 2.2lb/sec, with a controlled downstream pressure of 40lb/sq in.

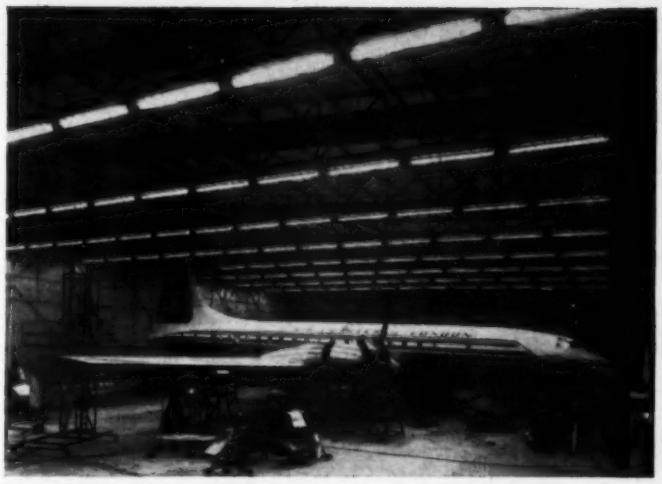
The current range of equipment is available in three principal variations as follows:—

Package Unit.—A portable control and distribution unit for use with air cylinders provided by the operator on his own transporter vehicle.

Jetstart Mk IV.—A towable trolley carrying 12 air storage bottles. With or without heat exchanger, it is capable of three to four engine starts.

Jetstart Mk V.—As the Mk IV, but with 24-bottle capacity and capable of six to eight starts.

Other Variations.—The basic starter unit has been incorporated into various design-studies to meet diverse requirements. The most sophisticated of these consists of a prime mover with built-in twin compressors and an alternator to provide heating for a heat exchanger. The heat exchanger, which is optional in all variants, can consist of an electrically heated element or a burner unit using kerosine.



This Britannia of Air Charter Ltd, at the Southend Airport maintenance hangar of the associated company Aviation Traders (Engineering) Ltd, is seen in the brilliant but shadow-free radiance of a lighting system installed by the Benjamin Electric Co Ltd, of London N17. The installation consists of 8ft 125W Taskmaster fluorescent fittings coupled in continuous runs, with reflectors permitting a degree of upward lighting

Geoffrey E. Knight (left) and Eric L. Beverley, who—as reported last week—have been respectively appointed commercial manager and sales manager (guided weapons) of the British Aircraft Corporation

Perhaps puzzling at first sight, this photograph shows the first stage in the manufacture of glass fibre—molten glass from an electric furnace being drawn in fine filaments through platinum dies. It was taken in the new Camberley, Surrey, factory of Glass Yarns & Deeside Fabrics Ltd (a company of the Microcell Group), opened recently by Harold Watkinson, the Minister of Defence. Also at Camberley is another Microcell subsidiary, Artrite Resins Ltd, where glass fibre is used in the manufacture of reinforced polyester plastics

Lox for the AW.660

AN initial order for 20 sets of 25-litre liquid oxygen breathing systems has been received by British Oxygen Aviation Services in collaboration with Aro Equipment Corporation of USA. The order has been placed by Sir W. G. Armstrong Whitworth Aircraft Ltd, who are installing the equipment in the AW.660, the military transport version of the Argosy.

This means, state BOAS, that the AW.660 will be the first transport aircraft in service in the United Kingdom using lox breathing equipment. The crew system will employ diluter demand regulators designed and manufactured by British Oxygen Aro Equipment Ltd.

IN BRIEF

D. S. MacIntyre, BSc, has been appointed projects manager of Ultra Electronics Ltd, following the resignation of F. W. Holmes.

Appointments announced by the Dowty group include those of F. Bastow as managing director of Dowty Seals Ltd and C. N. King as a director of Dowty Hydraulic Units Ltd. Mr Bastow, who joined Dowty in 1937, was originally with Avro, and Mr King, who joined in 1953, was with the MoS (on radar development) and subsequently with Exactor Ltd, where he was chief engineer and a director.

Aeronautical Bookshelf

Fighter Command, by AVM Peter Wykeham. Putnam & Co. Ltd, 42 Great Russell Street, London WC1. Price 30s. Illustrated.

HERE is the case for the defence of Fighter Command itself. It is a defence of quiet persuasion which leads us through the years from 1916 to the present day and its terrible threat of nuclear attack. The plea in this imposing brief which Peter Wykeham uses so adroitly is that Fighter Command has always successfully defended Britain. Its past history, which he recalls at length, is convincing evidence. During the Battle of Britain (glorious stuff this, but frankly old hat now) the Command quite definitely beat the German Air Force, though again we see by how small a margin.

Since 1945 the Command has been steadily rebuilt, and the final chapters of this book claim that it is now in fine shape; yet nowhere is there an assurance that our modern fighters and the first generation of guided weapons could defend us as well as did our fighters in 1940. But they will, goes on the defence (and here the case weakens), "hold off the threat of the bomber until the bomber is replaced by the rocket." Will the jury believe this after reading how, all through its history, the Command has never given a 100 per cent defence? And today just one bomber getting through could well be failure: if war breaks out the mission will have failed. There is little in the book which gives me much hope that the Command could effectively stop war starting.

Yet, after all, is this the case? Why has not the author explained just how effective Fighter Command really is? He has underplayed the part, missed the golden chance of ramming home all the arguments for retention. Instead he seems to be seeing the end of the Command in the not-too-distant future. The end of the book even sounds a little like an epilogue to a wonderful story which has been told with vigour and in masterly style.

That propaganda point has been lost. Others are suitably exploited—there are strong arguments against the Press and the public for imagining that scientific capability has advanced further than it really has. "The result," AVM Wykeham writes, "is to a tendency to treat today as if it was already the day after tomorrow . . . in air defence it is both dangerous and expensive." How futile it is to confuse "science" writers' predictions with operational requirements. Had the Spitfire and Hurricane been cancelled before the war because even better aircraft were being designed, we should have had no defence in 1940—because the new aircraft would not have been ready. A. C. B.

Great Aircraft, by Wg Cdr Norman Macmillan. G. Bell & Sons Ltd, York House, Portugal Street, London WC2. Price 21s. Illustrated.

HOW can we judge whether an aircraft is "great"? Is it not the men who designed, built and flew it who are the great ones, for without them the aircraft would not have existed? But such esoteric questions were not in Wg Cdr Macmillan's mind when he wrote his latest book.

Many will challenge his own selection of the ten great ones; but few would quarrel with the reasons he gives for their greatness. Each section on different designs is a valuable history in itself. This reviewer must confess to not having even heard of one—the Pixie, designed and built by Harold Bolas for the light aeroplane competition at Lympne in 1923. Here was a successful failure! It never went into production, though it did everything else expected of it, including one thing which was certainly not guaranteed—it flew with both wing spars cracked and the engine firing on only one of its two cylinders.

Behind this nostalgic and eminently readable book is a great story of research and careful writing. It is all pleasantly spiced with the flavour of authenticity which this author gives to all his books, and which springs, perhaps, from an almost overplus of personal knowledge of aviation. A. C. B.

The Survival Book, by P. H. Nesbitt, A. W. Pond and W. Allen. D. Van Nostrand Co Ltd, 358 Kensington High Street, London W14. Price 56s 6d. Illustrated.

THIS is a text book on how to save your life, and the lives of other people, should you find yourself stranded in one of the more unhospitable and unpopulated areas of the world. It has been compiled by three Americans whose experience in such regions is unquestionable, and they have brought together an absolute wealth of useful information.

The opening pages discuss the stresses that the castaway is likely to suffer from climate, animal life, and personal nervous influences resulting from his predicament. This is followed by a consideration of emergency first-aid; signalling for help; providing shelter, fire, water and food; finding direction and location from the celestial bodies; and crossing various types of terrain. The remainder is given over to more detailed discussion of the environments where survival is likely to be exceptionally difficult—arctic and sub-arctic, desert, tropical rain forest, sub-tropical grasslands, coastlines and at sea. A whole chapter is devoted to a discussion of the advisability or otherwise of drinking seawater.

But how many travellers will find this excellent publication at hand in their hour of need—when sitting on a raft, an icefloe or sand dune many miles from anywhere? Should one, therefore, tuck it in one's shirt-front at take-off, or would it be safer to learn the whole thing by heart beforehand? This thought in turn prompts the consideration that the authors have hardly been as realistic as they might have been; they nearly always assume that the survivor will have managed to rescue almost everything that he needs to sustain his life. A few more hints on what to do when you have only your trousers, and a pair of braces to hold them up with, would have been welcome. The book is well illustrated with drawings on such subjects as methods of trapping animals, diagrams of non-poisonous fungi, plants and fishes, where to find water in various geological formations, and how these relate to the geomorphological background. The photographs are not up to the same standard. Tables on everything from how long a man can live at certain ambient temperatures on so many cups of water to sun azimuths at dawn and sunset are provided.

No one should get himself force-landed or ditched without this book. P. R.

Science as History, by Heinz Gartmann (translated from the German by Alan G. Readett). Hodder & Stoughton Ltd, London EC4. Price 25s. Illustrated.

AN example of excellent popular science writing for the layman. It tells him how electronic computers, satellites and other such objects really work. Much of the credit for the clear concise language must go to Mr Readett for his translation.

Science as History is the story of invention and technology in modern times; sometimes it deals specifically with aviation, but mostly it is concerned with general matters which have benefited mankind. This leads inevitably to the race for the stars, and to Dr Eugen Sanger's controversial lecture in February 1955 when he spoke of the probability of rockets flying at the speed of light. These photon-rockets of the future are so amazing that, one feels, even the cold scientific mind of the author is impressed, and leads him (and his readers) to muse on whether mankind is yet sensible enough to follow and peacefully use the benefits that technology is providing. E. C. E.

The Practical Use of Radio Aids for Pilots, John A. Terras, ARAeS. Sir Isaac Pitman & Sons Ltd, Pitman House, Parker Street, Kingsway, London WC2. Price 12s 6d. Illustrated.

IF every flight took place in quiescent air many of the problems facing the airman seeking to find his way across the face of the earth would never arise. But in practice the air is scarcely ever still, and allowance has to be made for the wind component. Understanding and using radio navigation aids effectively depends not only on understanding the equipment and its purpose, but on the way that it can be used to calculate, and then to anticipate, variations in drift that come with every change of heading.

This is an elementary and oft-repeated lesson in John A. Terras' useful radio aid primer. He explains ADF, VOR, QDMs and ILS —those magic symbols of the twentieth-century navigator—by illustrations of their use, so that from the first example in the book the effect of wind is always there. This is the essentially practical approach and the theory in these 67 pages is of the rule-of-thumb variety. There is a certain amount of arithmetic, but all of it the sort of sums that a pilot must do in his head —at first consciously and laboriously and then, with experience, by a process that is almost intuitive.

While not an easy book to read through—there are too many examples and reference diagrams for that—*Radio Aids* fulfils very well the limited textbook task it sets out to achieve. It is quite comprehensive and as an adjunct to instrument flying practice—Link or actual—it should serve a useful purpose. A. T. P.

OTHER BOOKS RECEIVED

Space Travel, by Kenneth Johns. Frederick Muller Ltd, Ludgate House, 110 Fleet Street, London EC4. Price 8s 6d.

There Shall Be Wings, by Leslie Roberts. George G. Harrap & Co Ltd, 182 High Holborn, London WC1. Price 21s.

"The Aeroplane" Directory of British Aviation 1960. Temple Press Ltd, Bowling Green Lane, London EC1. Price 30s.

Driving Whirlwinds, by Robert Morison. Lew Singer, 3 Kent Road, Acton Green, London W4. Price 2s 6d.

"The Engineer" Buyers Guide 1960. "The Engineer," 28 Essex Street, Strand, London WC2. Price 7s 6d.

Hypersonic Flow, edited by A. R. Collar and J. Tinkler (proceedings of the Eleventh Symposium of the Colston Research Society, April 6-April 8, 1959). Butterworths Scientific Publications, 4 & 5 Bell Yard, London WC2. Price 70s.

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The Aerodynamics of Powered Flight, by R. Carroll. Chapman and Hall Ltd, 37 Essex Street, London WC2. Price 68s.

Thirty Seconds at Quetta, by Robert Jackson. Evans Brothers Ltd, Montague House, Russell Square, London WC1. Price 21s.

Final Approach, by Christopher Hodder-Williams. Hodder & Stoughton Ltd, Warwick Square, London EC4. Price 15s.

Correspondence

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns. Names and addresses of writers, not for publication in detail, must in all cases accompany letters.

Airline Vertical Separation

I WAS interested in Roger Bacon's little comment of May 27 on the seemingly small vertical separation near Gander of an eastbound 707 and a westbound Comet. On checking the levels given (39,000ft and 42,000ft respectively), I find that these do not tally with the usual Atlantic procedures, which would be eastbound 37,000ft or 41,000ft and westbound 39,000ft or 43,000ft —a pardonable error on your columnist's part, since the scheme of flight levels is not clearly set forth in the ICAO Regional Plan and in any event permits variation by mutual agreement between the Gander and Shanwick controls. However, I expect that the intended separation was 2,000ft (and not 3,000ft as given), this being the general concept for the upper airspace.

But the point about the photograph of the Comet contrail [referred to by Roger Bacon, and published on May 20, page 677] is that it doesn't look like 3,000ft vertical separation, or even 2,000ft, above the 707. It probably wasn't. For some six years now the ICAO Panel on Vertical Separation has been studying the problem of ensuring a safe interval, but still we receive reports of near misses in the upper levels between aircraft supposedly separated by 1,000ft up to 29,000ft and 2,000ft thereafter. The last meeting of the panel made a number of fairly optimistic assumptions but, even so, calculated that at 40,000ft on three occasions in a thousand one might expect 1,240ft of the nominal 2,000ft separation to be consumed by a combination of instrument, static pressure and height-holding errors—more if one took into account sub-standard temperatures and sharing the airway with the military, who are reluctant to fit static-system correction cards. Perhaps the photographer was having his 998th flight and the law of averages was just catching up on him!

This brings me to the point: is the assumption of a three-in-a-thousand risk (the basis of the official studies so far) justifiable? In my view it may well be justifiable off the airways and holding stacks, since it means no more than that, of 1,000 aircraft *flying anywhere in the world*, three will have the bad luck to be at the same height even though their altimeters indicate that they have the prescribed vertical separation. The world is a biggish place, and the three unlucky aircraft would normally have a job to find one another. But if one channels these 1,000 aircraft into an airway, sending 500 eastbound over Gander on a VOR radial and 500 westbound, then three of them will be vertically within 500ft of each other if they are at about 40,000ft (upper level, 2,000ft nominal separation) and running head on at about 20,000ft (1,000ft nominal separation).

Clearly, horizontal scatter will somewhat alleviate this gloomy picture, but there is a great tendency for this to be pretty small near the VORs. As a matter of fact, nobody seems to have carried out a study of horizontal scatter on an airway. It would be very useful in connection with this problem and should not be too difficult in a field of radar coverage—indeed, where better than at Gander? One could then see if the three aircraft "earmarked" by the law of averages to lose vertical separation would be likely to be on the same track when they passed, or two miles to one side.

As your photograph so vividly illustrates, distance lends enchantment to the view.

London W1 C. C. JACKSON,
Executive Secretary, International
Federation of Air Line Pilots Associations

"SAS and the Caravelle"

WHILST welcoming the publication of statistics by *Flight*, I think it is only fair to point out that the sort of statistics reported as being given by Knut Hagrup of SAS ("SAS and the Caravelle," page 699, May 20) are the kind that led people in the past to list the order of infamy as "(1) lies, (2) damn lies, (3) statistics."

When comparing "malfunctionings" of medium-range aircraft with those of long-range aircraft, it is surely reasonable, just as it is customary, to use the hours flown rather than the number of take-offs as the reference basis: on this basis we get:—

Aircraft type	Technical delays per 1,000 hours flown	Malfunctions per 1,000 hours flown
CV-440	9	346
DC-6	12	406
DC-6B	11	268
DC-7C	14	277
Caravelle	35	520

Which, comparing the DC-7C and Caravelle, paints an entirely different picture from that quoted by Mr Hagrup.

Lytham St Annes, Lancs J. F. Foss

Shoreham Echo

I ENJOYED the report in the May 27 issue of *Flight* concerning the weather-marred Shoreham Tournament, but as a visitor I left there with some feeling of having been "done."

With three other friends, all of us members of the Royal Observer Corps, we hired a car, changed our duties to finish work early, and dashed off from Kent at 11 a.m. on the Saturday.

All this, knowing how grim conditions were for flying, and not knowing if we would get to see anything at all, after reading your encouraging paragraph in the May 20 *Flight*—"No arrangements have been made to cater for members of the general public who wish to view the competition." Knowing we would at least get into the airfield after seeing the board which reads "Shoreham Airport, open to the public" on previous occasions, we were halted at the gate and charged 5s.

At the time we were clueless as to what was happening (this time being after 12 noon) but after reading the latest issue of *Flight* I realize, that in fact, it was all over and we were seeing a few circuits and bumps. At least we were more than pleased just to see the aircraft that had struggled through the murk to Shoreham.

But the five bob, what was it for? and who was the chap on the gate who had it, and in return gave us a ticket from a book, having no price marked on it?

Edenbridge, Kent A. H. G. JEFFREY
(Chief Observer, 21/S2 Post, ROC)

[We understand that the charge was one levied—but not by the Royal Aero Club—for car parking.—Ed.]

Short History

From Oswald Short, Hon FRAeS, FZS, FRAS

FOR some years past *Who's Who in Aviation* has been stating that Sir Arthur Gouge, now retired from Saunders-Roe Ltd, was responsible for all Short aircraft from 1926 to 1943. I feel that the words "responsible for" are in need of some qualification, since all the aircraft mentioned were based on my patents. My first patent, No 185,992, was finally accepted on September 21, 1922, but the Silver Streak was first exhibited by me on July 12, 1920. The delay in granting the patent was owing to a search made by my patent agents. On the first page the specification states:—

"The present invention relates to improvements in the construction of Acroplane Flying Machines in which it is desired to provide an all metal construction and *moreover* a construction in which a light and strong metal such as 'Duralumin' can be advantageously and safely employed to constitute the main part or body of the Structure."

I have no wish to belittle Sir Arthur Gouge's abilities as an engineer and designer; but he was not responsible for the basic principles of any of the aircraft he mentions, especially the Sarafand, to which I shall refer later.

Mr Gouge joined Short Brothers as a fitter when we were at Eastchurch, where Horace Short invented and patented the first aeroplanes and seaplanes with folding wings. I invented and patented the sprung main floats and tail float. Our aircraft were made of wood, with wire bracing, covered with linen fabric and dressed with Cellon. Horace died in 1917.

At Eastchurch in 1911 I had invented streamlined rubber air bags to be fitted to aeroplanes so that in the event of engine failure they could safely alight on water. Lt (now Air Chief Marshal Sir Arthur) Longmore, who watched these tests, flew the machine from Eastchurch Aerodrome and alighted on water off the Isle of Grain in the same year.

Mr Gouge left Chatham Dockyard and was given employment by Horace Short as a fitter in 1915. Horace would have nothing to do with balloons or airships filled with inflammable gas, but he designed the wooden fins and rudders for the *Mayfly*, the hull of which was built by Vickers at Barrow-in-Furness 1909-1910. I designed the gas compartments, valves and pressure gauges. My late brother Eustace and I made the outer cover of pure silk woven for us with equal warp and weft by Brocklehurst & Sons Ltd.

I first met Arthur Gouge when I opened a laboratory at Rochester, where I wanted to carry out secret experiments. I asked the works manager, the late Mr William Pictcairn Kemp, if he knew of a good mechanic, and he recommended Arthur Gouge, who, he told me, had passed an examination and was a BSc. When I met Mr Gouge his first remark to me was "If I am going to work with you I want one pound per week rise." I told him I was going to give him a rise of two pounds per week, and he seemed satisfied.

One of the tests we made was on my laminated Duralumin spar. I found that he made a good job of the framework which held the spar at one end. The Silver Streak was built before I even knew his name.

The technical director of the Air Ministry was doubtful of stressed-skin metal aircraft made of Duralumin because of its supposed excessive liability to corrosion. This was possibly due to the fact that the frames of Zeppelin airships shot down in England were badly corroded. I put this serious corrosion down to use of material from scrap-heaps which also contained scrap ferrous metals, and began experiments with plates of Duralumin and mild steel. I put 6in-square plates of both metals on the end of our launching pier at Rochester, where they would be immersed in

CORRESPONDENCE . . .

salt water at high tide. After about six months the Duralumin was spotted very evenly with corrosion, but it did not penetrate into the metal. On the other hand, the mild-steel plate was rusted right through at the centre, though only rusty on the rest of the plate. It occurred to me that there was a transference of electrons from the Duralumin plate to the steel plate and of ions from the latter to the Duralumin. Therefore I carried out another experiment. To the centre of the Duralumin plate I attached a copper tube, at the end of which was fitted a zinc plate 1½in square. After about three weeks the zinc had almost disintegrated, but the Duralumin plate was quite free from any corrosion spits.

The Sarafand was *entirely* my conception. It was not built to an Air Ministry specification. For some reason or other the technical department of the Air Ministry were opposed to the use of engines above a certain horsepower and were also opposed to big flying-boats. They contended that the increase of structure weight would prevent any increase of performance. I had already built the all-metal hull for F.5 and it was flying in December 1924. The hull embodied my second patent, No 241,362 (application date November 28, 1924, complete acceptance December 31, 1925). From these dates it will be seen that I had this hull well under construction before applying for a patent. It was the success of this hull which led the technical department to order six stressed-skin metal hulls for the Supermarine Aviation company's Southampton flying-boat.

The Air Ministry technical department had thus abandoned the theory of intercrystallization of light alloys at this early date. Prof Leslie Aitchison, who was consulting metallurgist to the Air Ministry, left in 1924 to become superintendent of James Booth & Co Ltd, who were making Duralumin under licence from the Germans. Sir Arthur Gouge was present when I convinced him by test that the tiny spots of corrosion on the plate did not penetrate into the metal, and enlarged in that supposed process. If at any time in trying mixtures of non-ferrous metals with aluminium James Booth & Sons had used zinc, then I think intercrystallization might have occurred. Following my experiments with zinc attached by a copper tube to a plate of Duralumin, I employed this method later on the wing-tip floats of the Sarafand when I had put on a stainless-steel bottom, rather to appease the technical department of the Air Ministry than any other reason. Mr Gouge also designed and built the stainless-steel tube upper spar of the Sarafand. The stainless-steel bottom set up pinpoint corrosion on the Duralumin wing-tip floats. I reminded Mr Gouge of my early experiment, so a slot was made to take a small zinc plate at the end of the wing-tip floats, and this cleared all pinpoint corrosion from the floats. The zinc plates could readily be replaced.

I did not produce a flying-boat made of Duralumin until 1923. This was the single-seater Cockle built by Mr Lebius Horden of Australia, but later purchased by the Air Ministry. My first military-type all-metal hull was tested in wooden model form in the NPL tank at Teddington. The tank was not always easily available, so at a cost of £4,000 I built our own tank at Rochester. Mr Gouge designed the tank on the lines of that of the NPL, though it was much smaller. I placed him in charge of this tank, with Mr Lower and a model-maker to help him. Thus we could work day and night if necessary, and we made great progress.

In 1934 the Singapore III was flying, and six were ordered. As a guest of the Air Ministry I flew with four of these boats from Pembroke Dock to Karachi and made the first non-stop flight down the Persian Gulf from Basra to Ras-el Khima. We now had what was known as the "standard" flying-boat of the RAF.

Success after 14 years of financial risk and considerable financial loss, to prove that Duralumin and stressed-skin construction could be safely used in aircraft construction!

Haslemere, Surrey — OSWALD SHORT

DC-1 at Work

HAVING greatly enjoyed the Editor's fine report "South by DC-8" on page 467 of your April 8 issue, I hope he won't object if I take him to task on his remarks "all, I find, except Dash One, who never got around to going to work anyway."

Most certainly, although the revolutionary Douglas DC-1 never got beyond the prototype, it certainly enjoyed for itself and its several owners something of a unique and not altogether undistinguished career between the years 1933 and the end of 1940. Having made its historic first flight on July 1, 1933 (piloted by Carl Cover with Fred Herman as co-pilot and flight-observer), it was handed over to TWA in December of the same year. The airline operated it on most of their main routes, mainly for proving and a great deal of experimental work, including the testing of a new Sperry autopilot and Kreusi radio compass, on behalf of the (then) US Department of Commerce and the USAAC.

In April 1935 the DC-1 was loaned by TWA to the NAA for American attempts on various FAI recognized world records, for speeds, loads carried, and distances covered. Between May 16 and 18 (flown by TWA Captains Tomlinson and Bartles) it set no fewer than 19 new world and USA records.

In 1936 Howard Hughes intended to use the DC-1 on a round-the-world flight he and his team were then planning. Extensive modifications were carried out on the aeroplane, and fuselage tanks were fitted giving it an (estimated) still-air range of about 6,000 miles: the powerplants were also changed to Wright Cyclones F.25s, developing 875 h.p.

Later, Hughes and his team decided to use a specially built Lockheed Super Electra, and on May 27, 1938, Hughes sold the DC-1 to Viscount Forbes. It was shipped to the UK on a freighter, unloaded on a lighter to the Ford Motor Company's dock at Dagenham. There it was assembled by KLM engineers, and was flown from Dagenham Common—a mere football pitch—to Croydon Aerodrome, piloted by the late Capt W. Rogers of Imperial Airways. It seems its distinguished British owner didn't keep it long, because he sold it to an (undisclosed) French operator in about August of the same year.

Likewise, the French owners quickly sold the DC-1 and in September 1938 it became EC-AAE on the Spanish register, and owned by LAPE, the government airline at that time. With the Spanish Civil War coming to an end, in April 1939 and with a party of Republican Spaniards aboard, the DC-1 was flown to Toulouse. Upon capitulation of the Republican Forces, a party of Spanish Nationalist Air Force personnel collected the aeroplane and flew it to Madrid, where it was given a much-needed Check 4. In the new colours of Iberia it went into regular service on the Seville/Malaga/Tetuan route until early in December 1940 it made a belly-landing due to engine-failure on take-off, and was written-off, being broken up by Spanish Air Force men.

During its colourful and indeed varied career this distinguished ancestor of *all* the DCs had at least three very near misses in several hundred flights it made: also, back in its birthplace (Santa Monica Field, California) whilst it was parked on the tarmac near its hangar, a stunting Bücker Jungmeister flown by famous Col Ernst Udet (he was visiting the small Douglas factory, having taken part in the National Air Races at Clevelands in 1932) narrowly missed hitting the DC-1 when his engine cut whilst looping.

In conclusion, I am much indebted to David Spurgeon (late BEA and now with Transair) for making available much of this little-known data regarding the DC-1's ownership in the UK and Spain, and its final "resting place."

Enclosed are two rare photographs of the good old "Dash One" when she was being assembled at Dagenham: her UK registration was G-AFIF, for those who keep such records.

Nairobi, Kenya — DENNIS M. POWELL.

FORTHCOMING EVENTS

June 10. RAeS Rotorcraft Section: "Helicopter Vibration," by Dr J. P. Jones.
June 11. College of Aeronautics, Cranfield: Public Open Day. Also Cranfield Society a.g.m. and Dinner.
June 11-12. Cholet Aero Club: Touring Aircraft Meeting.
June 12. International Landing Contest, Brussels.
June 12. Wolverhampton Aero Club: Competitions Day.
June 12-18. International Institute of Welding: Annual Assembly in Liége.
June 17-18. Lozère Aero Club: Rally, Mende-Brenoux.
June 18-19. West Aero Club of France: 14th International Wine Rally, Angers.
June 19. French Aero Club: Rotorcraft Grand Prix.
June 19. Yorkshire Aeroplane Club At Home, Yeadon.
June 22-28. FAI: Aerial tour of Europe (provisional date).
June 25. RAFA Air Display, Staverton.
June 25-27. RAeC: Invitation Air Rally, Escoublac/La Baule.
June 28. Guild of Air Pilots and Air Navigators: Presentation of Meteorological Office awards.

First of a world-famous series: the Douglas DC-1 in England (see letter above from Dennis M. Powell)

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